FACTORY MANAGEMENT and MAINTENANCE

OCTOBER, 1933

Successful Selling Begins in the Plant

Red Ink or Black?

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Comptroller
The Wahl Company, Chicago

Lower prices, better service, new ideas attract reluctant sales dollars

ROUTINE cooperation between sales and factory has not sufficed for the past three years. Salesmen have had to meet demands for lower prices, better service, and new ideas to attract reluctant dollars—which comes squarely back to better factory methods, new thinking on the part of factory men.

Back in 1929 the Wahl Company possessed a modern plant and organization. Company executives might well have asked: "What can be done that we are not doing now?" Instead, they took the attitude that nothing was so well done it could not be bettered. Department afer department was gone over, not only once or twice, but a third and fourth time, in their search for the right answer to current business conditions.

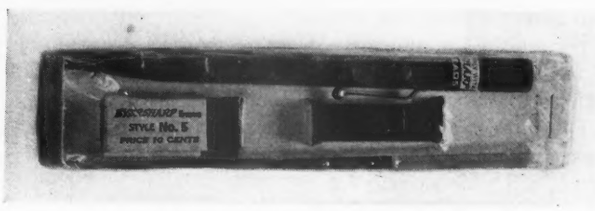
The answer was found. In one department alone, more than $50,000 was saved. Nor was this the largest economy. Inventories were cut; customer service and dealer relations were improved.

Naturally the effects of the tuning up will not be confined to the depression period; they will be equally useful as business improves. Only a few of the economies effected can be described here; they deal with varied activities, but they may prove suggestive in themselves, and at least they serve to illustrate an approach which regards production, selling, and finance as merely the details of the one central problem of performing a service at a profit.

1. Because inventories were unduly heavy, and ready cash was at a premium, excess stocks were among the first things to be investigated. It was found that a comparatively simple expedient would reduce inventories a third. The plastic compound used for modern pen and pencil barrels requires seasoning after each major forming process—several months in all. Practice had been to assemble pens complete and put them into stock, ready for sale. This meant tying up a large investment in the points, with their gold and precious metal nibs. An interchangeable point was therefore developed. Points are now produced to close stock limits and assembled as the pens are sold.

Incidentally, the interchangeable point principle was turned into a strong sales argument. With a dozen pens and interchangeable points the dealer can offer the customer just as many combinations of points and barrels

Up top, a new ink, new bottle, new package brought new sales; below, a lead and pencil combination sold for 39 cents, introduced a new "square" lead, created a new supply market



Product movement lines were straightened out and shortened. The assembly of the "square lead" pencil was broken into balanced operations and put on a straight-line production basis

of different colors and designs as he could with a gross of the old-style pens.

The same principle of interchangeability, applied to the boxes in which individual pens and pencils are packed, cut the package stock in half. Two standard plain cardboard bottoms and twelve fancy covers now meet all needs.

2. A dependable stockroom is the foundation of dependable manufacturing. Physical storage facilities were improved in a number of small but important details. Bins were painted and numbered. Sample parts, secured to the front of the bin, now aid in locating materials. Rubber eraser tips must be fresh; a bin was built which fills from the top and empties from the bottom. From five to ten bins are check-counted every day to make sure that the book inventory is accurate.

3. Another cost reduction, which also increased inventory turnover, was the straightening out and shortening of product movement lines, and corresponding adjustments of organization throughout the plant.

Manufacturing departments had been functional; machining had been completed in one department, assembling was done in another, and so on. Machines were rearranged, conveyors installed, and machines and crews balanced to give straight-line production. Since barrels and caps of pens and pencils are basically similar in many points of manufacture, the same lines serve either for pens or pencils by adjusting some of the positions. Operators are trained to perform all operations on the lines, giving great flexibility. They are stationed on both sides of assembly benches; holes were cut in walls to permit the erection of conveyors so that parts might be fed to succeeding operators where certain operations, such as buffing, had to be done behind closed doors.

The most important parts of the pen, the barrels and caps, are now kept in parts stock in blank form. This effects a double saving, for not only is labor investment reduced, but by facing to length or changing style of banding, a blank barrel or cap can be finished in any one of several styles.

By these changes the time required for assembly was cut anywhere from seven to ten days. Less supervision was needed, because of the consolidation of the various departments. Departmental foremen were replaced by group leaders. Operators do not go chasing around for parts. Machines are set up by the tool-crib man, who also cares for and stores the dies in a central crib.

4. Process and mechanical improvements were not neglected in this thorough-going overhaul of plant and product. A special turret-lathe head was developed which enables one man to perform operations formerly done by two or three. Mechanical devices facilitate the building of certain pens and pencils in the smaller quantites required under present conditions.

On one machine, for example, the operator faces to length a pencil barrel, assembles shell and clip, marks names, assembles tip mechanism, counts and loads leads in the magazine, assembles eraser and mount, all at one sitting. The only remaining job is to assemble the cap; this is omitted from the previous operation because each cap is fitted individually to the pencil.

5. Flow principles, which worked so well in production, were also applied to final storage and shipping. In the first place, departments were largely consolidated. Desk sets had been assembled by a separate unit; this unit was absorbed by finished stores—a move that did away with the need to carry a working stock of completed desk sets and to assemble a set which, after six months' storage, might have to be repolished. Desk sets are now made up from stock as ordered.

Final inspection, labeling, cleaning, and packing were also divided between the finished stock department and the producing departments. By postponing these operations until the item passes into the small current stock

from which shipments are made, investment is reduced, stock is always freshly polished.

Packing and checking were put on a progressive basis, reducing the cost, increasing the accuracy, since every step in the checking, being a standard routine, is sure to be done. An improved check sheet and procedure also contributed to speed and accuracy.

From a sales standpoint, the reduction of complaints due to mistakes in shipments was one of the factory's most helpful contributions to easier selling.

Another step was to consolidate the advertising supply department with shipping. The shipment of advertising literature and displays, while presenting differences in bulk of package, benefits otherwise from the same routine of checking, packing, weighing, and routing that applies to the products themselves. Merchandise and advertising material often go out now in one shipment.

6. To tie up some loose ends in the previous control, production and stock control were brought together in one office. Production had been on the basis of annual sales quotas. With smaller lots, less certainty, and more variety of styles, quotas gave way to stock-limit control, with close limits. Production orders are made up each day by the production superintendent, from a daily list of items approaching or at minimum.

Before the present plant of production control was established, the parts stockroom was used as a clearing station for production orders, "die stamp" (or special) orders, returned goods, and finished products, as well as finished parts. Owing to lack of control in the production department, and to inability to locate parts with certainty in storerooms or in process, the stock clerk frequently issued orders for parts already in process or in stock. A serious unbalance of inventory resulted, which it has taken nearly a year to correct. Centralization of responsibilities and records, and a closer and simpler control eliminated this difficulty.

7. Supplementing these various detailed improvements, consolidating the gains, and unifying the objectives of all departments, is a comprehensive budget control. All operating departments work to standard product costs and to departmental expense budgets, prepared in collaboration with the comptroller's department. Each department receives a monthly report which concentrates attention on the variances, whether favorable or otherwise, from the accepted budgets and standard costs. Similar budgets control sales expense, and objective measures of sales potential give a measure of sales results to be expected.

Both in selling and production, the budget serves quickly to indicate the weak points at which effort must be concentrated if the goal is to be reached.

Workmen are on bonus. Prizes are given for suggestions. Throughout the organization men have clear-cut tasks and definite measures of performance, and benefit in material ways from meeting and exceeding standards.

Brief mention must also be made of a research accomplishment which materially broadened the field open to our salesmen, and in which factory men as well as sales and research men played their part. As a result of this development work, which should not be omitted in any comprehensive survey of sales possibilities via the factory, a lower-priced line of pens and pencils was developed, as well as new and attractive styling of all lines. A "clean-fill" ink bottle and an improved ink helped broaden the market. A "square" lead was developed which writes better, because it does not turn. Sold in combination with a "red top" pencil at special prices, it has substantially increased sales.

Thus the inquiry begun on account of diminishing sales did not rest until it had been extended to every activity of the organization. The results—as here set down in part—have been plenty good enough to convince the Wahl management that it can subscribe to no better working philosophy under present operating conditions than "Successful selling begins in the plant."

Better packing methods are credited with a saving of $50,000 a year. Boxes were standardized, finished stocks cut a third, errors made conspicuous by their absence

Principal Developments in Electrical Control Equipment

The third article in a series on advances in important items of industrial equipment. Previous articles covered Plant Service and Mechanical Power Transmission Equipment

Direct-Current Controls

Improvements, but no radical changes, have been made in control for the d.c. machinery used in industrial plants.

In a d.c. contactor developed for mill and crane controllers, the arc is forced into a so-called "gas wedge," which keeps it in motion. Burning is reduced, which prolongs the life of contact tips, arc box, and other adjacent parts. The high-speed opening of the contact assists in rapid extinguishing of the arc.

An across-the-line automatic starter that was brought out has provision for adjustable timing in order to permit the field current to build up to full strength before the armature circuit is closed. With this feature it is said that the inrush current can be reduced about 50 per cent.

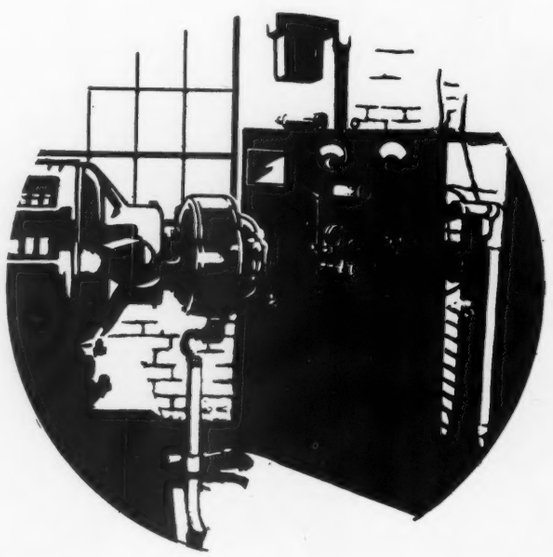
Alternating-Current Controls

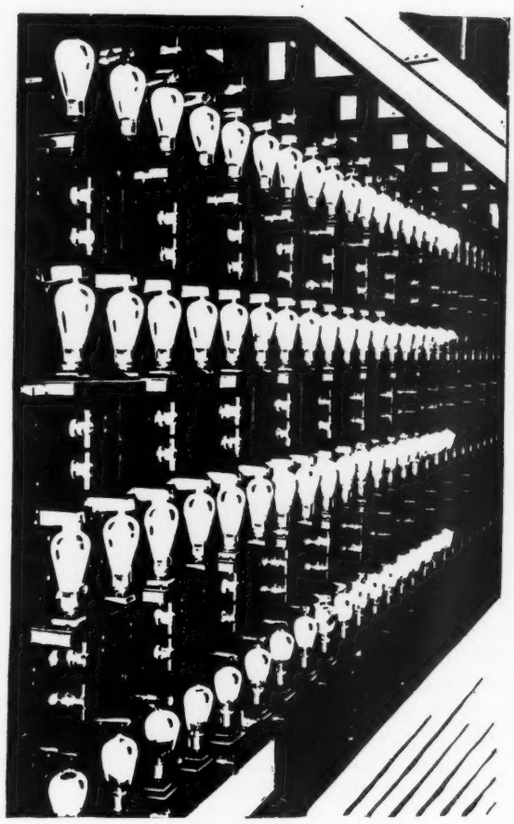
The tendency has been toward expansion of a.c. control equipment to include as standard items a large number of specialized control units. Development also includes an increase in the number of specialized control stations, such as multiple stations for standard service, splash-proof service, explosion-proof service, dust-tight service, and the like. Included also is a wide variety of pilot control stations operated with levers instead of pushbuttons.

Increasing use of across-the-line motors has stimulated design of contactors suitable for interrupting fairly heavy currents. Pitting, roughening, and fusing have been almost completely eliminated by the use of rolling contacts made of hard copper. Welding and corrosion are often prevented by use of silver-to-silver contacts. Special provision is made to prevent flashovers between adjacent line contactors. In the smaller sizes, arc hoods of special design extinguish any arc. In the larger sizes, magnetic blowout coils are often used to blow the arc upward between arc shields, where it is extinguished.

Manually operated switches for starting small a.c. motors directly across the line are still widely used. Heretofore, with hand-operated switches, fuses were used for motor protection; overload relays were used in connection with a magnetic starting switch. Now an improved switch operated mechanically by pushbuttons is available. On an overload, relays trip the switch open, and the operator must repeat the starting cycle of the switch. No-voltage protection is not provided: this feature is obtainable only with a magnetic switch.

Developments in magnetically operated switches include (in addition to relay improvements which will be discussed below) a wider use of solenoid-operated contactors. The solenoid principle eliminates many objections to the clapper-type switches, in which hinged construction and armatures are used. Vibration from outside sources cannot jar the contactor into a closed position. Solenoid switches, because they have no pivots,





flexible joints, or springs, are extremely rugged and require little attention.

In one magnetic switch the contactor remains closed indefinitely without consuming any magnetizing current. No current flows through any magnetic circuit except at the moment of opening or closing the contactor.

An across-the-line switch has been developed which is inter-connected with a hand-operated disconnect switch, thus eliminating the conduit wiring required when separate disconnect switches are used. It is intended to displace the older types of starter installations with separate disconnect switches. The combination starter can be mounted as a unit on a machine near the motor and permits motorized machines to be moved with minimum expense and disturbance to wiring and conduit connections. The disconnect switches are operated by means of a hand lever, and the cabinet cannot be opened unless the lever is in the Off position.

For service where extremely dusty conditions are encountered, switches are available with inclosing cover, sealed by means of a felt gasket. For use in chemical plants, paint rooms, and the like, and for any service requiring starters that can be operated with safety in fume-laden or explosive atmospheres, the cover and base are machined to a close fit. One small switch of this type employs a one-piece multiple-chambered arc hood which prevents flash-over between contacts when the starter is required to open an excessive overload current.

Most of the present-day switches are used in connection with inverse-time-limit relays which permit them to carry the large starting current, but protect against sustained overloads.

Some high-tension squirrel-cage motors are designed with high-reactance rotors, for starting directly across the line. Switches available for this service may also be used as primary switches in connection with slipring motors having a high-voltage primary. Overload protection is usually effected through current transformers in two primary phases; the secondary current of these transformers energizes the coils of overload relays.

Shading coils are usually imbedded in the pole faces of the operating coils to create phase displacement between the two parts of the pole face, so that the constant pull exerted on the armature reduces or eliminates humming.

Starting of high-tension polyphase motors has been made simpler by the use of time-delay relays. Low-voltage starting is obtained through an auto-transformer having taps that supply 50, 65, and 80 per cent of line voltage. After the start button is pressed, the motor automatically accelerates to full speed.

To overcome undesirable surges which accompany across-the-line and low-voltage starting, an automatic increment starter has been developed. In one such type, pressing the start button closes a magnetic switch connecting the motor to the line in series with graphite compression resistors. Gradual pressure on these resistors decrease their resistance. A time-delay relay controls the time lapse before the resistors are fully compressed, when full voltage is applied to the motor.

To provide control for multi-speed motors, which have been gaining in prominence, unique methods of interlocking pushbutton controls have been devised.

Drum controllers and speed regulators have also been improved. They are designed for starting, speed-changing, and reversing three-phase and two-phase multiple-speed motors, and for starting and regulating the speed of large polyphase wound-rotor motors. In modern types contact fingers are easily disassembled. Contact tips are made of hard extruded copper and are silver-plated to assure good contact. Interlocking arrangements insure that the motor will be started only when all the resistance is in the secondary circuit.

Control accessories, such as various types of push-buttons, available with pilot lights and safety lock levers, automatic pressure and float switches, and the like, have also been improved.

Control Relays

Development of the thermal overload, magnetic overload, and combination thermal and magnetic overload relays has made possible modern automatic motor control. Relays that permit accurate time-setting make sequence operation possible. Thermal-magnetic relays equipped with dashpots provide excellent motor protection, because their inverse-time characteristics—which give them long delay on slight overloads, but cause immediate operation on heavy overloads—insure adequate

protection without causing interruptions of service due to harmless overloads.

Electric Time Switches

For automatic sequence operations, ingenious electric time switches have been developed which control accurately their time and order. After the first setting, circuits can be energized and de-energized at definite intervals, with certain days or hours omitted as desired. The large number of time combinations obtainable make such switches applicable to a wide variety of conditions.

Electronic Tubes

In today's usage the term "electronic tube" includes light-sensitive cells and thermionic tubes. In the light-sensitive cell, emission of electrons, upon which operation depends, is caused by light striking a specially coated electrode. Thermionic tubes depend upon electron emission from a heated filament. The adoption of these devices in plant applications has been the most outstanding industrial development in equipment during the past three years.

Light-Sensitive Cells

Three principal types of light-sensitive cells are available—the photo-emissive, the photo-conductive, and the photo-voltaic. These names indicate the cell action. In the first type, light striking a coated filament causes emission of electrons, which are attracted to an anode. The cell is usually gas-filled, rather than highly evacuated, since ionization of the gas permits a greater current flow. It is this type of cell which is principally used in industry today.

Cells of the second type utilize some material, like selenium, which becomes a fairly good conductor when light strikes it, but is practically a non-conductor while in darkness. A disadvantage of this type of cell is its sluggish response to light impulses, so that it does not find wide application where high-speed action is necessary.

The third type of light-sensitive cell acts like a battery when light strikes it, setting up a small current. Photo-voltaic cells may be of either the electrolytic or electronic variety. In the former, two electrodes are immersed in an electrolyte much in the manner of simple galvanic cells. In electronic cells two electrodes are in contact, and the incidence of light causes a displacement of electrons from one electrode to the other.

Commercial development of the electronic photo-voltaic cell probably has been the most important development in light-sensitive cells during the past few years. This cell forms a dry, compact unit which needs no external source of voltage in order to actuate a relay. The relays, of course, must be more sensitive than those used with the older type of phototube, which is used in conjunction with vacuum tube amplification.

An electronic-voltaic cell is available with a light frequency response very similar to that of the human eye, which makes it especially valuable in color-matching work. Its impulse-frequency response is rapid enough to permit it to be used for rapid counting.

One important application of this cell has been its use with a millivoltmeter calibrated in foot-candles. With this combination light intensities can be easily read.

Light-sensitive outfits in which the necessary relays and controls are combined into compact units have been on the market for some time. The change in electrical characteristics of the cell under the influence of light is used to control the plate current of an amplifier tube, to trigger off a glow tube, or to disturb a balanced circuit. In the photo-voltaic cell, a current sufficient to operate a sensitive relay is set up. In some cases these phototube outfits also contain the light source.

There are many uses of phototube relays in industry, chiefly for illumination control, counting, starting and stopping equipment, and in conjunction with safety devices on machinery. Cells are available with characteristics especially suited to their various applications.

Vacuum and Gas Tubes

In order to apply electronic tubes successfully to industrial control, it was necessary to develop tubes capable of passing a comparatively heavy plate current, thus eliminating the necessity of using intervening mechanical relays. Gaseous tubes have been designed for this purpose, and may be considered as contactors when used in conjunction with phototubes or the ordinary vacuum tube, the latter then serving as a relay.

These tubes, which depend upon ionization of the gas or mercury vapor with which they are filled to pass current from filament to plate, in addition to electronic emission from the filament, are now available with capacities sufficient for any industrial application.

High-output rectifiers as well as inverters—devices for producing alternating current of any desired frequency from a d.c. source—have been made available.

So-called "glow" tubes may be had if a trigger action for starting and stopping substantial currents by means of extremely weak impulses is desired.

Since the output of the grid-controlled tube depends upon the phase relationships in the grid circuit as well as upon voltage and current variations, it may be used as a frequency controller, in addition to regulating the speed and output of motors and generators. A device is now available that makes use of phototubes and thermionic tubes, both vacuum and gaseous, for close frequency control of motor-generator sets.

An electronic timing control device has been developed for use on welders and other machines which operate on a repeated cycle, that must be accurately timed.

It is particularly adapted to projection, spot, and flash welding machines, on which accurate timing is extremely important in order to assure consistently strong perfect welds. The timing period is determined by the discharge of a condenser on the grid of a tube through a variable resistor. The time period is dependent upon the setting of the variable resistor, which can be adjusted.

[Next month's article will summarize developments in Electrical Distribution Equipment.—Ed.]

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When everyone's on the "flying squadron," it

Costs Less to Package

ON OUR packaging floor, the entire force has been developed with the idea that each person must be able to handle every other job on the floor. The only exception is that women are not expected to learn jobs which involve heavy labor, such as handling filled shipping cases. Results have been exceedingly satisfactory.

Work in this department is intermittent on various products. The only packing line which runs every day is coffee, and it runs only the hours required to fill the orders received that morning. Otherwise the department runs merely large enough stocks to take care of the supply for a four-weeks' period.

Since the work is thus sporadic, and since it is desirable to keep all the force profitably employed all of the time, it is essential to have a completely flexible force. This is accomplished by shifting the squads every week. For instance, suppose that the period's requirement of toothpaste can be packed in a week; it requires a squad of six —three to run the filling machine, two cartoning, one packing. The last time toothpaste was run, this job employed Girls A, B, C, D, and Men E and F. This time it will probably use Girls G, H, I, J, and Men K and L. The assignment of squads is handled through the production office, where a conscious effort is made to keep them mixed.

Any man on the floor can handle any one of the six jobs in running toothpaste. Any girl can handle any job except packing, which includes some heavy labor. And this operation, as detailed, is typical of the entire packing floor and all its operations.

The plan involves an appreciable loss of speed for the first three or four months of employment. It would not be practical if there were a high rate of labor turnover. But there has been a very low turnover rate in this department ever since the plan was inaugurated, and much of the credit goes to the rotation of jobs. The people like the diversity of work. They go out of their way to learn jobs. As it happens, there are mechanics assigned to each packing line. But some of the girls have even learned the mechanics' job and can set up several of the machines on the floor. Incidentally, some of the packing jobs are unpleasant. Baking powder and spices are dusty. But nobody grumbles since it is all in the year's work.

There are three coffee lines. Perhaps only two of these lines are running when a heavy order for another size is received and the roasters chute the supply down for packing. With no advance notice, the foreman can shift over to the coffee lines any crews he can spare elsewhere. And in a few minutes, coffee line Number Three has swung into action.

The 100 per cent flying squadron also simplifies the relief plan. Between 9:45 and 10:15, and between 2:45 and 3:15, every employee gets a 10-minute relief period. When the relief time comes, it is easy to shut off a line which can be spared and is easy to shut down—such as baking powder, which involves no glue and consequently no gumming from a shutdown—and use this crew as relief operators all over the floor.

The floor employs 29 people. If there were no flexibility, if everybody knew only his or her own job, it would take 40 people. Even if there were two flying squadron crews, the floor would require 35 people. And this would mean uneven employment, would lead to greater labor turnover and consequent loss of skill.

Figure 1. Assembling the arc splitter for a circuit breaker. Parts dumped on table. Assembly slow and painful

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Figure 2. Same job, but no dumping. What a whale of a difference the few bins make! This girl assembles eleven arc splitters to every eight of her predecessor's. The circular bin set-up can be used on other jobs

Fewer Motions, More Output

Is motion study applicable only to certain assembling and machining operations? Is its chief aim that of producing two pieces per cycle instead of one? A look at the record, with its examples out of molding and forging, as well as assembling and machining practice, ought to convert the unbelievers—if any there be

ALL TYPES of jobs are open to motion analysis. The most striking examples and those which show the most sensational savings are the ones where two pieces are assembled or machined where only one piece had previously been handled per cycle. Most of the installations described in the past have been of this type, and this fact has tended to make some supervisors skeptical of the possibilities of applying the principles of motion economy to other jobs. Some of the illustrations submitted in this article should do much, therefore, to convince all that the possibilities of motion analysis are unlimited.

Various applications of motion analysis and the results obtained will be discussed. It is not claimed that the jobs are perfect; some readers may be able to suggest additional improvements. Where old and new methods are shown, the new method is a decided improvement over the old, and, however far from the "one best way," illustrates steps in the right direction.

Figure 1 shows an old method of making the assembly of the arc splitter for a circuit breaker. The various parts constituting the assembly were dumped on the table from pans or bags and had no definite location. While making the assembly, the operator sat on a stool which gave him no support for his back.

Figure 2 is a view of the new method of assembly. Only one piece per cycle is made, but the assembly has been made systematic. A table with a semi-circular row of bins has been provided. Different parts of the assembly have definite locations, and these locations are so arranged that both hands are used simultaneously. The height of the bench has been adjusted so that the operator may sit in a chair with a comfortable back while working. These simple but effective changes resulted in a 37 per cent saving in the assembly time.

Although this bench was designed for one particular piece of apparatus, it can be used for other assemblies. Where the activity does not warrant the expenditure for

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such equipment for one article, a similar bench may be constructed so that a number of small assemblies can be made on it. Taking advantage of the normal working area is one of the basic fundamentals of motion economy, and such a bench is constructed upon the principles of utilizing the normal working area to the maximum extent.

The welfare of the employee plays an important part in motion economy. Good will of the employees who have benefited from the results of motion study means as much to the company as the time saved. In the method used in the past to make molded line material, the inserts and the molding material were kept in tote pans on an ordinary bench. The hydraulic presses used in this work are heated by steam and then cooled by water after the parts are molded. With the old presses the steam and water valves were placed close to the floor, and the operator had to bend over to open and close them. During the course of a day's time this bending became extremely fatiguing.

An analysis of the job showed that the method could be greatly improved. A rack was made to hold the tote pans in which the materials are delivered. This rack is conveniently located at the rear of the molder's bench. The scale on which the materials are weighed is placed so that the molder can weigh the material and assemble the mold with the fewest possible motions. Since the one molder operates a group of presses, care was taken to place the bench so that the distance to each press was as short as possible. The old valves were discarded and new four-way valves were installed. Thus, one valve now controls both the steam and water and can be reached by the operator as he stands in a normal position. This installation resulted in a 15 per cent reduction in molding time and eliminated the most difficult part of the job from the workman's viewpoint.

The next example is of the same order, except that it covers a machining operation. The part is a molded gear which has two holes drilled in the web. Since this is a very active item, the drill press was adapted for performing the one operation only. The table of the drill press was low, making it necessary for the operator to bend over when he put the gear blank in the fixture. The lever closing the fixture was as the same level, and the operator had to stay in the stooped position while he closed the fixture. The drill press was a hand-feed machine, and the spindle lever was at such a height that

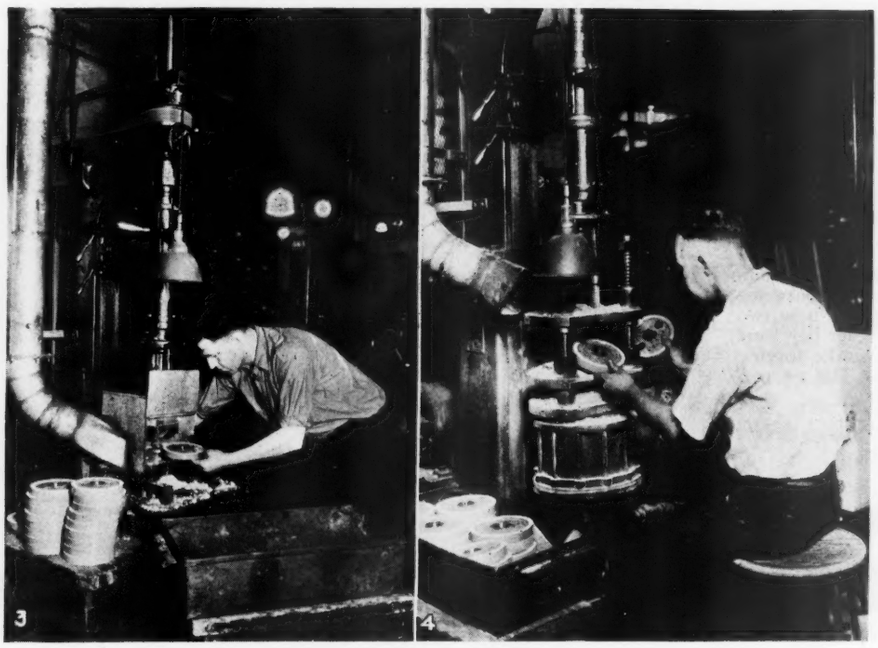

Figure 3. A drill press operation. Table so low operator had to bend to put gear blank in fixture, stay in stooped position to close it, then straighten up to reach the spindle lever. Constantly on his feet, constantly bending

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Figure 4. Now. Spindle stationary; table moved to it. Jig automatically closed. Operator seated. As part is drilled, both hands are free to lay completed piece aside and bring up the next one. Job easier, safer, 25 per cent faster

the operator had to straighten up in order to reach it. He was on his feet the entire time, and the constant bending was very difficult. In Figure 3, the operator can be seen placing a blank in the fixture.

The job was studied and tool men were called in. It was decided that an improved fixture could be made, eliminating the back-breaking part of the job and also increasing the safety of its operation. The features of the new fixture are: (1) The spindle is kept stationary, and the table is moved to the spindle; (2) the table is operated by an air cylinder; (3) the jig is closed automatically as the table moves to the spindle; (4) the operator is seated and, as the part is being drilled, has both hands free to place a completed piece aside and bring up the next piece to be drilled. Under the new method the job is easier, quicker, and safer, a saving of approximately 25 per cent being realized in the drilling time. By examining Figure 4, the general improvements can be seen.

The last illustration shows a job in the forge shop. To make this installation, tradition had to be pushed rudely aside. Those who were frankly skeptical are now offering suggestions for improving other jobs.

The job in question is a forged gear blank. There are various sizes of these blanks and all were previously forged on a 6,000-lb. steam hammer. The gang consisted of the forger, a hammer boy, and the helper. To even the most casual observer it was apparent that the time of the three men was not occupied to the best advantage. The cycle was as follows: the part was pulled from the furnace, placed on the hammer table, forged, rounded, and placed aside.

Although the forger and the hammer boy were busy most of the time, the helper was either idle or performing a holding operation. The latter pulled the blank from the furnace when the hammer boy opened the door and then, walking around the hammer, waited while it was partially forged. Next he held a gage on the table while the blank was forged to size and, again walking around the hammer, raised the die from the water tank and placed it on the hammer table. The forger put the blank in the die and finished it. The helper, having returned to his work station, put a ring under the die, as the forger raised it, and the blank was removed. The helper returned the ring to its location, picked up the completed blank with a pair of tongs and placed it on the floor. There was an excess of manual handling and holding throughout the cycle. There was also the possibility of the helper's pulling the red-hot blank off on his foot when he removed the knock-out ring.

After the job was studied it was decided that two men could perform the work. Chutes were placed to deliver the blanks from the furnace to the forger. The gage and knock-out ring were fastened on an arm and placed on a pivot in the rear of the table. A chute was provided to take away the completed part. Brackets were placed on top of the water tank to support the die, and a sprinkler was arranged to cool the die rather than dip it in the tank. All but the largest blanks were transferred to a 2,500-lb. steam hammer. This latter change reduced gas consumption, as the smaller hammer had smaller furnaces.

Figure 5 shows a comparative floor plan of both methods on the 2,500-lb. hammer and Figure 6 a photographic view of the new method. In this view the operator is forging the blank to size. The gage can be seen on the table and the knock-out ring back of the gage.

The new method is safer, and less fatiguing, and the cycle now takes less time for two men than the old cycle required for three. The total time saved amounted to 40 per cent.

These jobs were not developed by one man or one group of men. They represent the combined efforts of time-study men, tool designers, foremen, and in some cases the operators themselves.

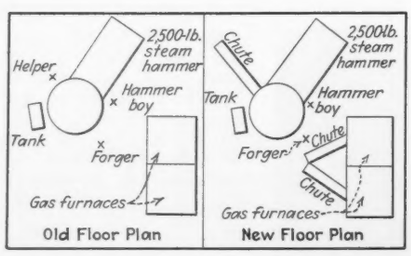
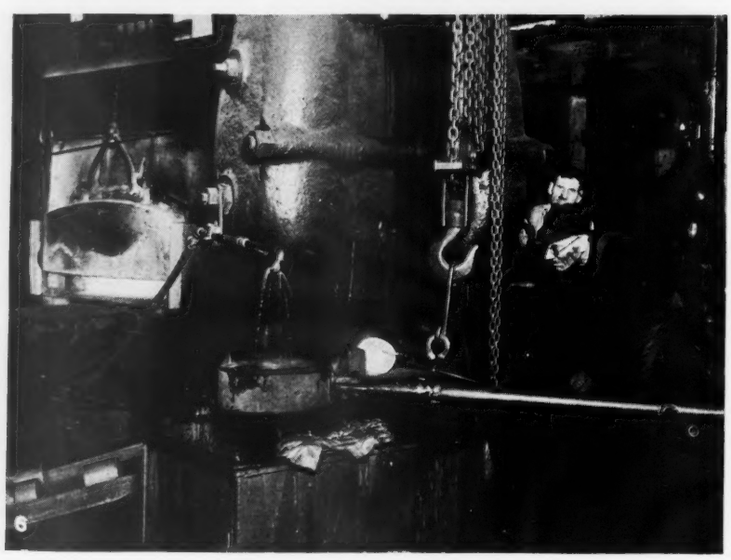
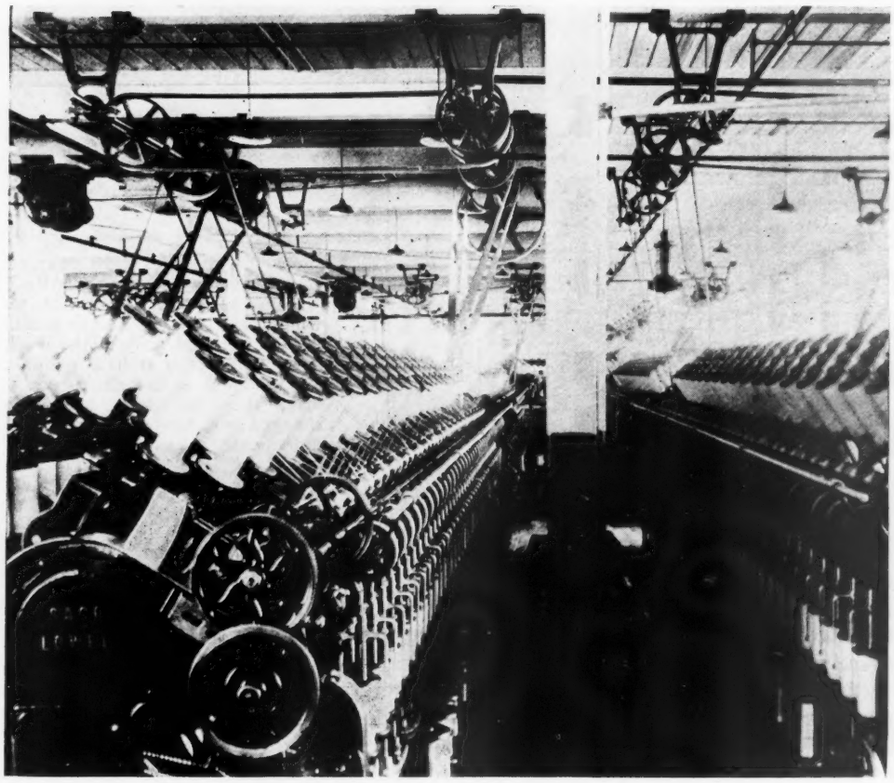


Figure 5. Even in the forge shop. Tradition was shoved rudely aside to make the changes shown in the newer of these two floor plans. Forger and hammer boy were busy most of the time during the forging cycle; the helper was either idle or performing a holding operation

Figure 6. The helper is no longer needed. Chutes deliver blanks from furnace to forger; another chute carries away the completed parts. Brackets support die. Die is cooled by sprinkler, doesn't have to be dipped in tank. Gage and knock-out ring easier to use. Whole operation safer, less fatiguing. Two men work faster than three. Time saved, 40 per cent





Short shafts with counter belts are preferable to long shafts, since the chances of misalignment are minimized and the power losses frequently are smaller

▼

What Modern Group Drive Is

Victor A. Hanson

Research Engineer
The Mechanical Power Engineering Associates

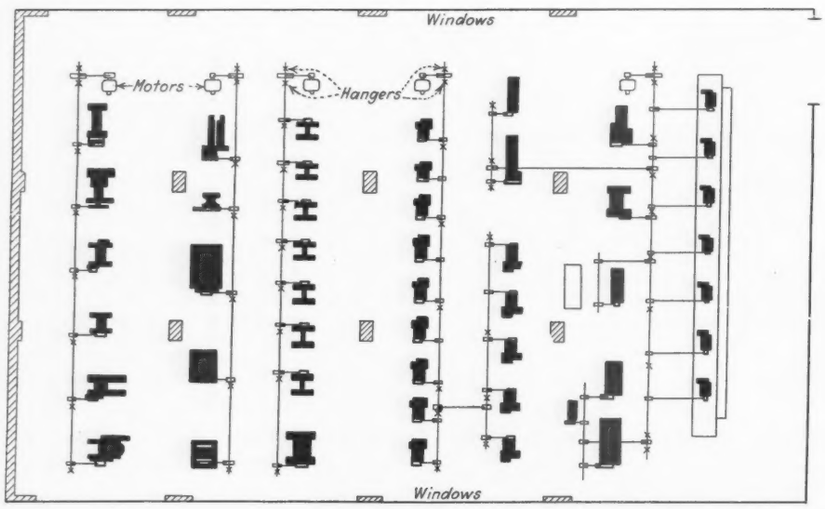
EVERYONE concerned with industrial plant operation has long been familiar with the term "group drive" and knows in a general way what it means. Within the past few years "modern" has been added to that term; so the question arises, Just what is meant by "modern group drive?" How and why does it differ from its predecessor? What do the differences mean, from a practical standpoint? The answers to these questions will be easier to understand if we recall what a group drive was originally. Examples of it are still to be found.

Developed in the days when a plant depended on one or two prime movers—steam engines or waterwheels—to drive all of the machinery, group drive meant one or more lineshafts anywhere from less than a hundred to, possibly, several hundred feet long. The shafts usually ran lengthwise of the building or room, which meant that there was little flexibility of layout; machines had to be located for convenience in reaching the lineshaft rather than for efficiency of operation, or other considerations.

More often than not location of overhead beams fixed the number and placing of hangers, so that the shaft might or might not be supported at the proper intervals. Furthermore, pulleys were likely to be placed on the shaft solely with regard to the location of the driven machines. If a pulley chanced to be placed close to a hanger, well and good; if not, it mattered little. Because of the fact that the loads on floors vary from time to time, timbers warp, foundations settle, it is very difficult to keep long lineshafts properly aligned. As a natural result a considerable amount of power was wasted in bending the heavy shafts to conform to the shapes imposed by hangers that were not in line.

Since those early days, plant layout, management, production methods, machine design and application, have all been subject to great improvement through years of research. With the development of mass production, flow lines, departmental operation, larger and higher speed machines, the increasingly severe demands placed on mechanical power transmission systems have necessitated important changes in equipment and methods.

Although modern group drive uses the same type of equipment as may be employed in the old-fashioned



Modern group drive layout designed to give maximum efficiency and production. With short shafts arranged at right angles to the windows, there is no detectable loss of light intensity at the working positions, due to belts. Motors are mounted at the shaft ends to make them accessible and easily changed to meet production requirements

group drive, it differs radically in design. The number of machines operated by one drive and one prime mover are relatively small, so that where it is desired to operate only a portion of the machines on a drive the prime mover still remains loaded to a degree that insures high efficiency. Many modern group drives are designed to operate only two, three, or four machines from one prime mover; with such drives it is possible to operate only one machine in the group with a high degree of economy.

The design of modern group drive also includes consideration of the flow of production and the natural grouping of machines by operations. Each group drive operates all or part of a complete production unit. In this way as the quantity of production is decreased complete drives may be shut down, keeping the remaining drives operating at their highest efficiency.

Occasionally the drive design must allow for shutting down some of the machines operated by it. In such cases the use of clutches, permitting the unused portions of shafting to be cut off, maintains efficiency at maximum. This is made possible by the fact that the efficiency of the type and size of motors employed on modern group drive remains practically unchanged from full to half load.

Machines may be placed in any desired position to give maximum production and convenience, the size and design of the modern group drive being sufficiently flexible for operation of machines in any position, at any angle.

Where lighting is of sufficient importance to affect the drive application, the drive is designed with shafts lying lengthwise to the source of light; thus only the thickness of the belting appears as an obstruction to the light. With this type of layout the drives have no measureable effect on the light delivered to the working surfaces.

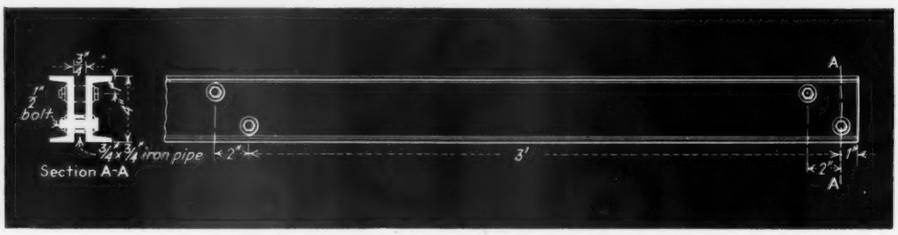
In the actual construction of a modern group drive there are several factors that must be considered. One of the first principles which should be applied is that of giving support at the points of load along the shaft. With modern group drive hangers are located at every pulley having a major load. Where two or more pulleys are grouped it is preferable to install a hanger between them, thus balancing the load on each side of the hanger.

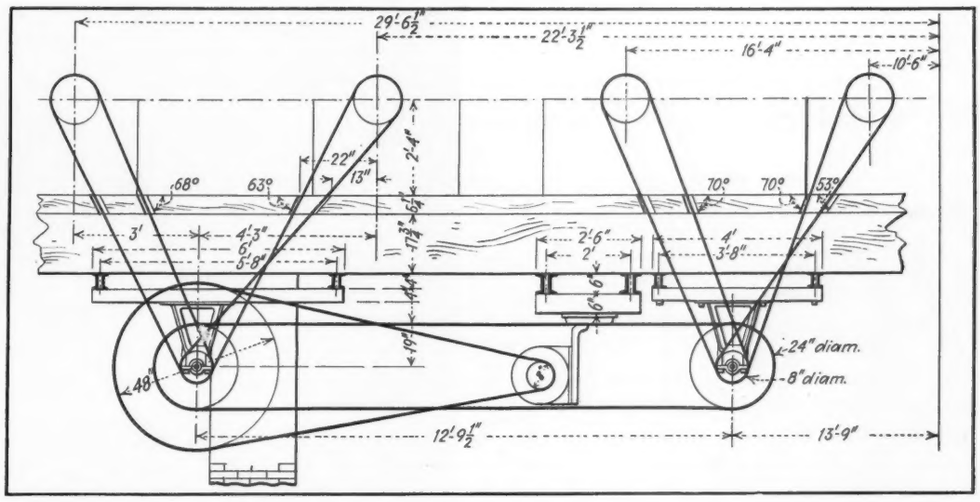
To install hangers at the points of load it is usually necessary to employ stringers. Steel stringers, consisting of two channels fabricated web to web but separated from $\frac{3}{4}$ to 1 in. to allow for hanger or cap bolts, are recommended for they not only allow for support at the point of load but are easy to install and add a degree of flexibility to group drive which has been unknown heretofore. Where steel caps of the same channel-iron construction are employed many drive changes may be made by loosening the hanger and cap bolts and sliding the members into the new positions. In this way, pulleys, hangers, shafts, and whole drives may be moved without any drilling of holes, frequently without even disassembly.

Shafts are comparatively short, although the length is determined largely by the type of operation and the machines driven. It is advisable and usually possible to keep shafts under 60 ft. in length, although occasionally longer shafts are found necessary. Short shaft lengths minimize the chances of misalignment. It is better to employ two or more shafts and counter belts than one extremely long shaft.

When laying out modern group drives particular attention should be paid to the peak loads of the machines and the relative capacity of the drive. With the old-fashioned group drive, more trouble is caused by overloads than from all other causes combined. Ample capacity in all equipment used not only eliminates trou-

Construction of steel stringers for supporting hangers. Space between channels may be varied, depending on the size of the hanger and the cap bolts needed. Suitable spacers may be made of 1-in. pipe cut to the desired length. Size of channels used also may be varied according to the load imposed





Modern group drive utilizing steel stringers and caps and installed below the floor. An advantage of underfloor drives is that the tension of the belts is partially counteracted by the weight of the shaft and pulleys, thus reducing bearing pressure and increasing the efficiency

ble but guarantees maximum production. However, unnecessarily heavy equipment may cause excessive power losses and high operating costs. To utilize relatively light equipment and at the same time have ample capacity requires that the drive speeds should be comparatively high.

In line with the utilization of higher speeds, the motors employed in modern group drive are of the higher speed type, since such motors operate at a higher efficiency and power factor than do low-speed motors. Motor sizes are also selected after careful check of the load and diversity factors, so as to permit the motors to operate under normal conditions at their maximum efficiencies and power factors. Control equipment includes jack-type disconnecting switches, which make it easy to check motor loads and power factor. All too frequently motors employed on old-fashioned group drives are found to be operating at low power factors and efficiencies, a fact that has gone undetected through lack of facilities to make the proper tests.

Peak loads developed by modern group drive are moderate and the starting loads are low. Therefore, it is ideally suited for operation by synchronous motors, which usually may be of an economical size. Thus, not only is power factor corrected, but the most common cause of low power factor is entirely eliminated.

Modern group drive is the result of a careful study of industrial conditions and requirements and the application of the most suitable equipment and methods to meet those requirements in a way that will give the maximum in production at minimum operating cost.

Modernization of industrial power transmission systems offers great opportunities for reducing operating costs and increasing plant production. Power drives, regardless of type, represent in themselves a sizeable investment worthy of careful consideration. Of even greater importance is the fact that the type and design of drives installed determines to a large extent the operating economy of the entire plant, thus making their proper application of great importance.

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90 Per Cent for Wages

THE FAR-REACHING employment benefits of the projected federal program to stimulate the construction and heavy industries are revealed in statistics just compiled by the Austin Company, engineers and builders, of Cleveland. These figures show that 89.3 per cent of the actual building and equipment cost in a recent construction job went for wages—at the site, in transportation, or at the source of material supply.

The total actual cost of the structure and the manufacturing equipment was $450,000. Of this amount, $402,280 went for wages, representing 805,310 man hours, or more than 100 days' work of 8 hours for 1,000 men.

Reduced to minerals in the ground or standing timber, basic raw materials used in the structure and in the manufacturing equipment actually cost only $39,300. To convert these raw materials into finished products, it is estimated that $250,370 was paid to unskilled and skilled labor in scores of plants throughout the country with practically every section feeling the impetus directly. An additional $84,410 was paid labor in the plant erection, $17,500 went to labor in transportation, and $50,000 to labor for the installation of plant equipment.

"This high proportion of money going to labor becomes even more significant in view of the fact that the so-called 'heavy industries,' including construction and other forms of capital investment, normally employ approximately 40 per cent of the nation's industrial workers," said W. J. Austin, president of the company. "Most of the increase in wages and salaries resulting from business pick-up has taken place to date in the 'consumer goods' industries—food, clothing, automobiles, and similar commodities. Recognition of the lag in 'capital goods' industries on the part of the government and industrial leaders is one hopeful sign of the recovery program."

Clock control will turn on your floodlights at dusk, turn them off at bedtime. Or, if you prefer, it will turn off your air conditioning for the night or the week-end

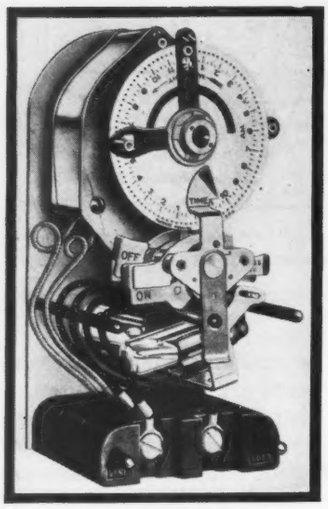


Figure 1. A single-dial electric time switch. Its mercury contactors will carry as much as 25 amp., and by connecting them in series or in parallel many sequence variations may be obtained. If more than one dial is used, complex sequences with scheduled intermissions are possible

"On again, off again" with electric time switches

Figure 2. An electric timer that rings a bell or lights a telltale

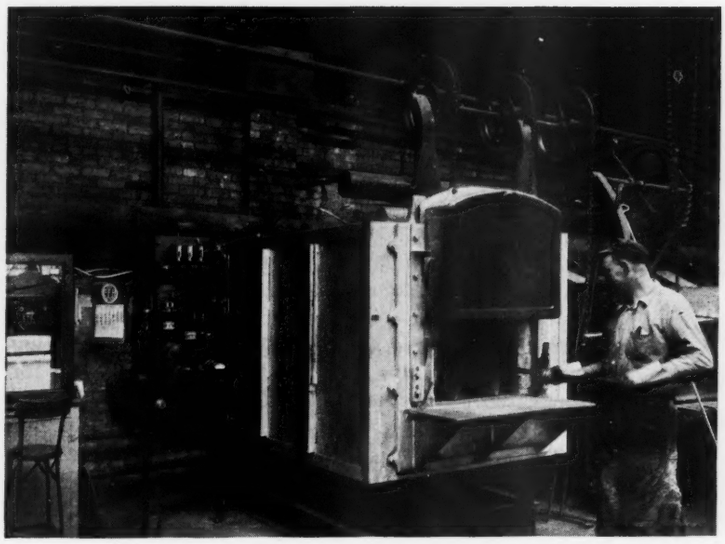
DOES some of your process work embody a definite sequence of operations? You can control it automatically. Even if your requirements call for omitting Saturday afternoons and Sundays, or every third Wednesday morning with time out for cleaning or curing, say, between 12:45 and 2:10 three days a week . . . . you can still control it automatically. Repetitive sequence operations—with any scheduled intermission you may need—are possible with modern electric clock control.

Take the device shown in Figure 1. It's a garden-variety electric time switch . . . . nothing custom built or special about it at all. But, even without the fancy additions with which it may be equipped, it can make all sorts of automatic machinery go through definitely timed cycles of operation, over and over again.

The past few years have brought a lot of refinements in switches like these—mercury contacts, for instance, whose life is practically unlimited because they don't fuse or pit; accurate synchronous clocks; and, most important of all—because it has made possible a host of sequence combinations—the use of two or more rotating dials.

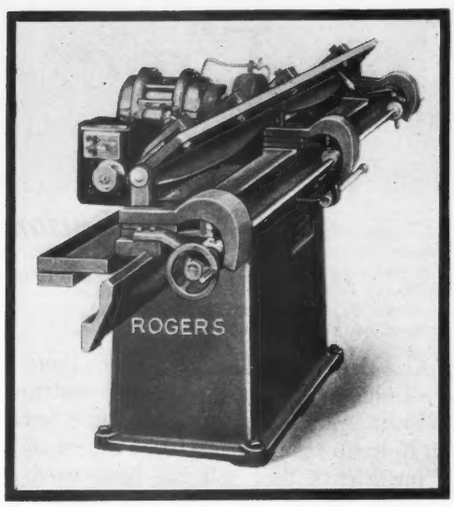
The dial is the actuating part of the device. Say it rotates once in 24 hours; then pins stuck at certain intervals along its perforated periphery can be made to trip the mercury contactors at any definite time desired. Obviously, if you have two or more dials, each operating at its own definite speed, you can get innumerable combinations at which certain pins are in juxtaposition; and by connecting the small mercury-tube contactors which they actuate in series or in parallel, amazingly complex sequences, with periodic omissions if desired, may be obtained.

Additional dials mean increased accuracy as well as increased versatility. For example, if a dial 5 in. in diameter revolves once in 24 hr., an eighth of an inch on its circumference represents almost $11\frac{1}{2}$ min. That means that a pin would take an appreciable time in actuating its contactors; and even where spring-operated, trigger-actuated contactors are employed, unavoidable play in the mechanism would make definite settings difficult to obtain. However, if a dial rotating once an hour is used in addition to the first one, and if the circuits they both close are connected in series, very much closer settings can be had, since an eighth of an inch on the second dial represents $\frac{1}{24} \times 11\frac{1}{2}$, less than half a minute.



Accurate timing control on electric heat-treating furnaces means uniform results

Operation of this knife grinder is stopped automatically at the end of any desired period by a time switch. Grinding time can be varied from 1 to 45 minutes



Wherever current must be turned on and off at stated intervals, there's a time switch itching for the job. It will protect process, product, and pocketbook

Carl Heyel

New York, N. Y.

Applications of electric time switches fall into two broad classes—those incorporated by manufacturers as an integral part of equipment, and those used by plant engineers, as a separate accessory, for some specific control purpose not included in the original design of certain automatic equipment.

The first class is by far the larger. Modern equipment in which manufacturers usually incorporate some sort of electric timing device includes bread machinery, dough mixers, dry cleaning apparatus, automatic knife grinders, ovens, and domestic heating appliances.

However, plant engineers often find it convenient to employ individual electrical timing devices to control cyclical processes. In the rubber industry, especially, electric time switches find wide application to certain molding operations.

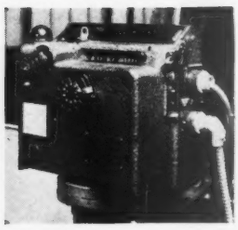
In this connection distinction must be made between "timer" and "clock control." The latter signifies cyclical operation; the former means that the operator has to set the switch for a certain time operation, and reset it after the work is performed. A typical electric timer is shown in Figure 2. Such a unit is used in connection with a bell or pilot light. Wide use is made of it in timing photographic developing.

The accompanying table lists the various types of processes and equipment where the plant engineer may find electric clock control especially useful in the interest of more accurate timing, or of operating economies.

In respect to most of the items listed in the table the uses of clock control suggest themselves. For example, in air conditioning it is often desirable to shut down the equipment during certain periods of the day or week. Where plants use unit heaters, it is convenient to regulate whole batteries of them with a single clock unit, perhaps shutting all groups down over the week-ends, and a large part of them overnight. If photo-cell control of lighting is not considered practicable, astronomical-type, clock-control units may be employed which conform to the changing lengths of the days.

Check List of Clock Control Applications

Air Conditioning	Heat Treating
Battery Charging	Heaters and Heating Plants
Battery Testing	Industrial Rate Protection
Blowers	Laboratory Apparatus
Burglar Alarms	Laundry Machinery
Conveyor Control	Lubrication, Automatic
Dairy Agitators	Motor Control
Display Lighting	Photographic Work
Drying Equipment	Protective Lighting
Electric Water Heaters	Refrigeration
Electro-Plating	Signal Systems
Fans	Siren Control
Floodlighting	Stokers
Fuel Economizers	Valves, Motor or Solenoid
Gas Producer Controls	Ventilation



Why Idle Machine Time?

H. Dudley Hanson

The Cleveland Graphite Bronze Company
Cleveland

IN A PLANT like ours, where there are many machining operations, recording instruments designed to analyze and control idle time have helped us to run to earth many unsuspected causes of loss. The tale of inefficiency they tell has been used as a check on foremen, set-up men, stock-handlers, time-study men, checkers, maintenance departments, toolmakers—in fact, on anyone and everyone whose job it is to serve operator and machine.

We ordinarily use our time analyzers in batteries of four or five. A good average result is thereby obtained, and peculiarities of individual operators or machines may be studied.

In every operation examined savings have been made, and in each saving to the employer the employee has benefited. We estimate that the instruments paid for themselves in four months—in a plant, incidentally, where years of careful time study has been continually cutting down lost time and motion.

For example, from my report dated Dec. 1, 1932:

"Average speed of operators for two weeks prior to installation—483 pieces per hour. . .

"Average speed of the operations during third week after installation—569 pieces per hour. . .

". . . 11,627 more pieces could be produced in the same number of hours—or the same number of pieces could be produced in a month that is 169 machine hours shorter (*i. e.,* a 14 per cent improvement). . .

"Saving per month on increased production. . $257.84
"Less extra premium earned. 54.41

"Net direct labor-saving per month. $203.43

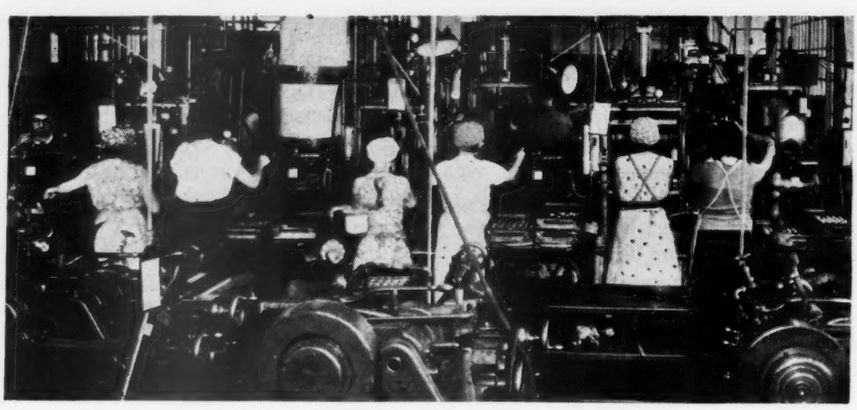
"Three main elements entering into this saving were: (*a*) installation of more costly but more efficient cutters; (*b*) improved materials handling; (*c*) cutting down of unnecessary idle time. They accounted for an increase of 7¼ cents per hour in operators' earnings."

Countless other examples could be cited out of our experience. On a press operation on strip stock in coils it was found that changing coils consumed the equivalent of 5½ minutes for each thousand pieces. A new stock stand was designed and installed, reducing idle time to 1½ minutes per thousand pieces.

In checking a facing operation, it was found that machining time was slowed down because chips got past unsuitable guards and took operators' minds and hands off production; furthermore, that production conditions and efficiency could be improved by reducing the limit on one dimension of the tool from "plus 0.0005—minus 0.000" to "plus 0.000—minus 0.0005." Result, machining speed increased 20 per cent.

Just one more. On another facing operation it was found that two of the four machines could be run 25 per cent faster and still remain within the operator's comfortable maximum speed of feeding. Result, more premium for the operators, reduced costs, increased production.

We have also found that time analyzers provide data from which rates of pay can be accurately checked. Every machining operation consists of actual machining time, necessary idle time (spent in tool adjustment, inspection of work requiring frequent checks, etc.), and unnecessary idle time (taken for personal matters, waiting for stock, cleaning machines, and so on). By ascertaining the correct machining time and the rate at which necessary idle time is consumed over a period of, say, 50 hours, it is possible to set a fair rate of pay. We feel, in conclusion, that the best efforts of good time-study men and tooling experts can always be improved upon with the aid of some one of the modern methods of controlling idle machine time.

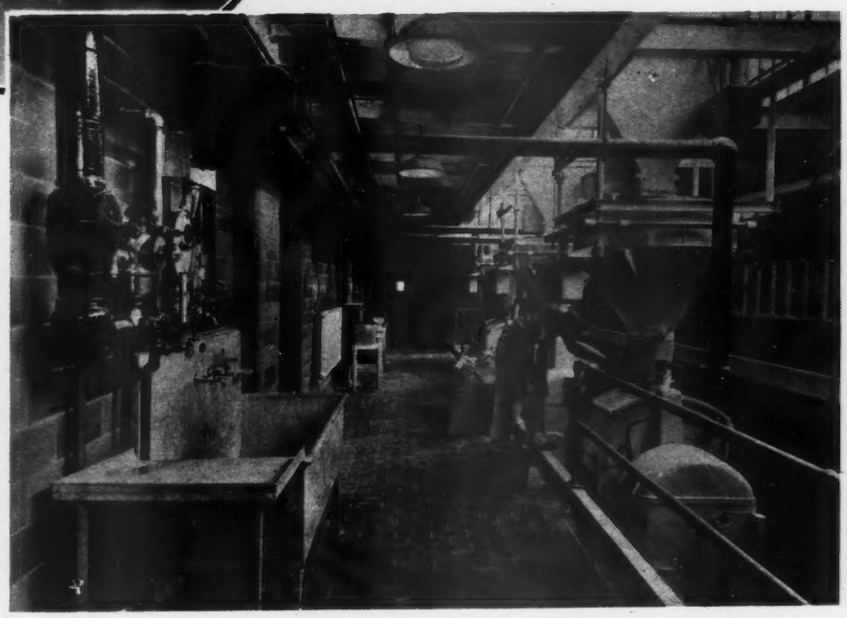


Time recording and analyzing instruments provide checks not on idle machine time alone, but on anyone and everyone whose job it is to serve the operator and his machine

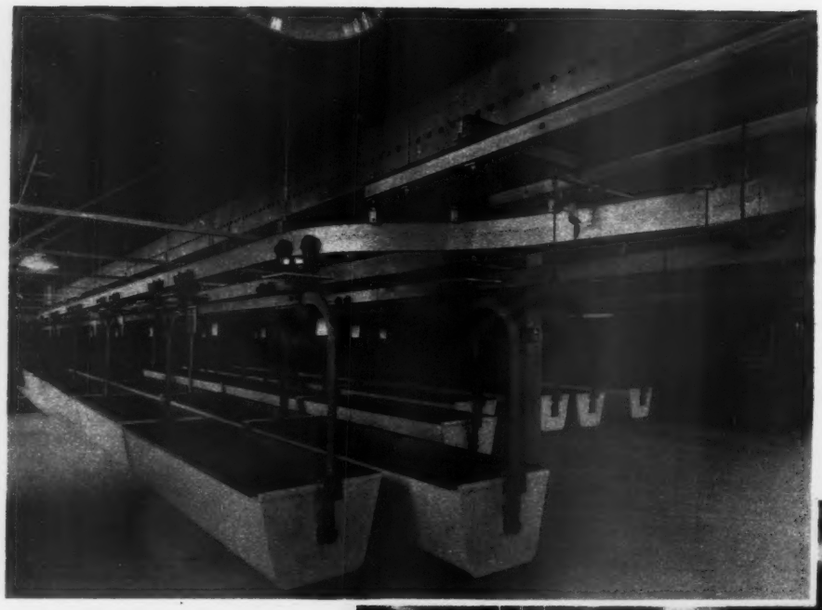
Well Handled Is Well Processed

When the William Freihofer Baking Company's Allentown, Pa., plant burned to the ground, the management was quick to realize that modern mechanical handling must be made an integral part of continuous processing. Thus the new bakery stands today, fully equipped to produce bread at the lowest manufacturing cost consistent with the maintenance of high standards and uniform quality

Sunlight floods the warehouse where flour is stored on skids. A specially constructed machine blends, sifts, and aerates the different varieties of flour at the rate of 175 pounds a minute. There is no dust. A screen conveyor takes the flour to a vertical bucket elevator, which in turn carries it to storage bins on the mixing floor. After the bags have been emptied, they are held momentarily over the suction pipe opening so that every last particle of flour will be extracted

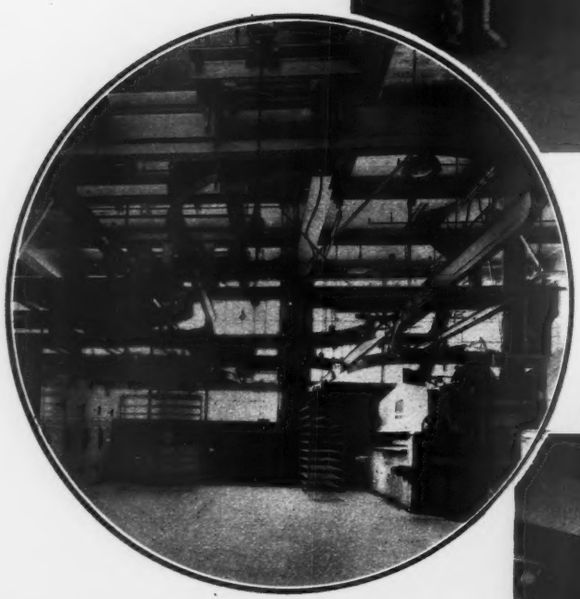


Accurate weighing and close temperature control are automatic guards of uniform quality. The operator works to established formulas, has only to set a series of dials on the scales. At once the correct amounts of blended flour and chilled water are weighed and dropped into the mixers. The mixing process is completed when the temperature of the dough has been raised to the correct figure



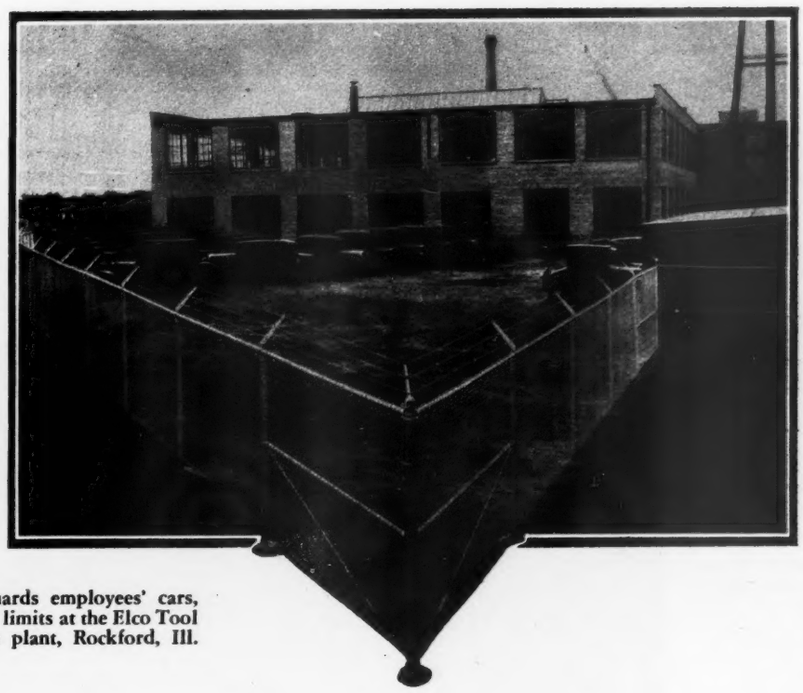
Last words in automatic equipment are these dividers and rounders. The former weigh off 1,000 pounds of dough every 18 minutes, and the latter shape it, handling a loaf a second. With dough it's up and down. The overhead proofer permits the yeast to ferment once more and helps the dough rise again. Now to the molder, then into pans, and by tramway into the proofing boxes in the background where the dough gets its final fermentation before going into the ovens

Uniform flavor is assured through close regulation of the fermentation process; this room is air-conditioned. Before the fire, troughs were on wheels; with the overhead system, handling is child's play



This is a bread cooler. Four thousand loaves travel through it every hour. They enter at 400 and leave at 80 degrees Fahrenheit, perfectly cooled by clean washed air supplied by the blower up on the shelf. Freihofer's Allentown plant had no cooler before the fire. Its installation is proof of the management's belief that through modern equipment lies the high road to low manufacturing cost, uniform quality, and profits

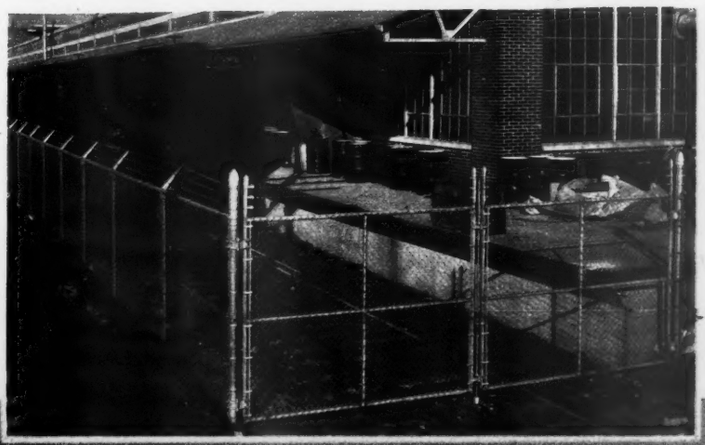
If accurate temperature control is essential in the earlier stages of bread making, it is paramount in the actual baking. Here are the feed ends of traveling ovens, each 800 feet long and with a capacity of 4,000 loaves an hour. Slow baking at carefully predetermined temperatures produces perfect loaves of bread. The overhead tramrail system brings the loaves to the oven, takes away the pans and carries them back again to the point of use



Industrial fence safeguards employees' cars, clearly defines property limits at the Elco Tool & Screw Corporation's plant, Rockford, Ill.

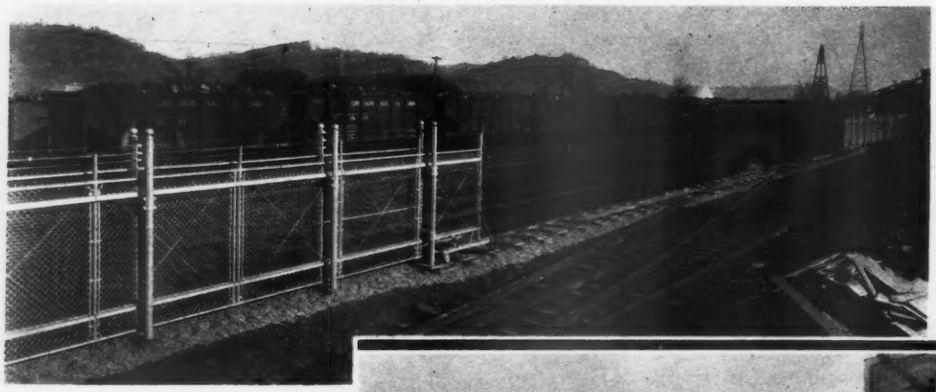
A Fence Around Your Plant

Protects Property, Improves Appearance, Provides Safety



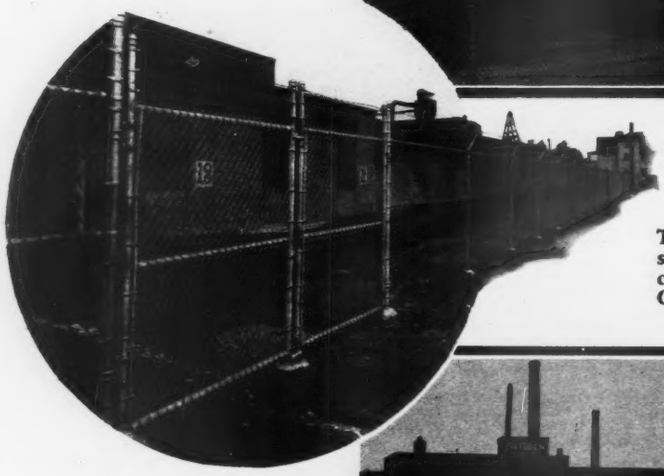
Much of the temptation to steal goods from this loading platform is removed. The fence is in the way

This installation at Keiner & Company's plant, Newark, N. J., makes it hard for the petty pilferer to do business

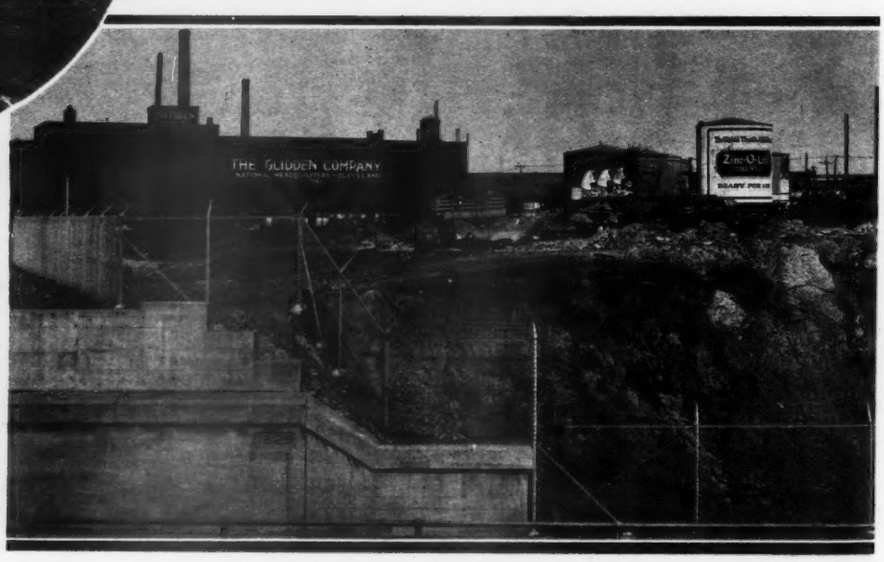


Out in the yards a sliding gate guards this railroad crossing

The A. E. Staley Manufacturing Company keeps out people who don't belong, improves the appearance of its plant with this sturdy barrier



Trespassers who don't believe in signs respect a high fence. Crucible Steel Casting Company, Cleveland



Several thousand feet of chain link fence incloses the Glidden Company's plant, provides property insurance at comparatively low cost

What's Ahead of Management Under the Codes?

Are the problems you *think* you'll have to face the ones that will actually confront you when you begin to operate under your industry's code? Mr. Rositzke's study, based on contacts with a number of textile executives, gives you a clue to the real tasks ahead of management, points out and develops five broad avenues of management approach

R. H. Rositzke

Management Consultant, New York, N. Y.

FIRST to operate fully under a code of fair competition, the textile industry has already had a number of interesting experiences, which may be profitably examined here in the thought of anticipating in some measure the problems soon to be met by other industries as they begin to operate under their own codes. Contact with members of the cotton, woolen, silk, and rayon conversion branches leads me to sum up in the following general statements the major opinions held by various executives when the code was first adopted:

1. Minimum wages as set forth in the codes will become the maximum wages.

2. With labor in the saddle, no changes can be made advisably at the present time; the present level of wages must be increased sufficiently to cover the minimum; in other cases the rates will be left alone.

3. With a minimum wage law in effect, there is greater need than ever for the elimination of needless waiting time, for incentives that are sufficiently attractive to sell themselves, for the reduction of equipment losses due to insufficient auxiliary equipment. Where codes restrict hours of machine activity all efforts must be directed toward increasing machine capacity.

4. Careful definition of what constitutes learners' periods is needed, and the differentiation between nonproductive and direct workers is essential.

These are the problems which textile executives *thought* they would be called upon to face. After experience with a pay period or two, the executives approached in this study found that they had had to modify their opinions considerably. It was the consensus of this group that operation under the code would place a high premium on well-balanced factory management. It was furthermore stressed that the approach to profitable operation lay through concentration on one or more of the following phases of management activity: (1) Production planning; (2) Use of cost-cutting equipment; (3) Plant cost control; (4) Employee relations; (5) Personnel training.

Production Planning—Plant executives operating under machine-hour limitations are tightening up productive schedules, revamping their planning departments for quicker and more effective control. Certain managers have seen the cost of idle employees' time reflected in allowances to a point that has led to:

1. Insistence that sales departments give a certain number of stand-by orders to use as a cushion for maintaining experienced operators required for special service and peak loads.

2. Increased desirability of longer runs, resulting in the necessity for modifications in hand-to-mouth inventory policies.

3. Elimination of all unnecessary but controllable waiting time.

4. Closer gaging of possible production; need for more accurate standards of machine capacities.

5. Careful establishment of working schedules to protect delivery requirements; observation of maximum working periods; and, where state labor laws regarding juveniles between 16 and 18 are in effect, the development of schedules avoiding employment of help beyond the specified latest working hours.

6. The development of data to show the current relationship of production as it should stand in comparison with the actual amounts produced.

7. More accurate reports and recording methods for determining and analyzing idle machine time.

8. Closer scheduling, to reduce excessive spread of orders over too many machines; lengthening of operators' runs, and consequent reduction in build-up and run-out losses.

The major thought is to establish methods that will minimize the need for sending employees home on short notice. If assured a day's work upon starting in the morning, employees are more apt to exert greater effort and at the same time will be far more contented to carry on.

Many examples of what manufacturers are doing in the way of better production planning can be cited. One silk weaver in the East, controlling several factories, was formerly satisfied with an over-all yardage control over

weave sheds. Since the very high minimum wage allowances, due to paying for waiting time, have been in effect, a detailed loom-control schedule board supplemented by a more thorough schedule of required weavers has been inaugurated. A specialty woolen manufacturer employing various sizes of looms used to schedule the weave shed. He now finds it necessary to schedule warps and warping creel time so that he will not be unduly handicapped by the necessity for inexperienced help.

Cost-Cutting Equipment—There seem to be two schools of thought regarding the value at present of purchasing higher-speed, modernized, and automatic machinery. The one school believes that the hue and cry over the "stretch system" will make such investments valueless. The other states that although the pressure of labor may restrict the number of machines per operator, it cannot place any restrictions on the basic increases in speed, efficiency, and, in most cases, parts and fixing cost reductions obtainable per machine.

Cost-minded executives realize that increased labor costs place an increased premium on their reduction. Such executives have calculated the basic influence of speed on the increased wage levels, considering present equipment assignments to operators and those that it is intimated may become standard. Their decisions, based on operating experience, lean towards adoption of modernized machinery.

Others, operating under codes restricting machine activity to 80 hours per week, previously operating on 24-hr. shifts, were faced with the necessity of discharging employees. Simultaneously such units have to absorb their production. All efforts are being made in these cases to improve the productivity of existing equipment. This they hope to accomplish through application of all available production increasing attachments. Recognition of need for newer automatic equipment has been forced.

All seem to concur in thinking that ample auxiliary equipment is necessary. Estimates of lost time due to waiting has definitely indicated the need for conveyors, sufficient lift trucks and skids, bobbins, warp beams, and other major auxiliary items.

The subject of lighting has been given considerable attention in operations converted from one to two 8-hr. shifts. This has been found extremely important because of early-morning and later-night light requirements. Two plant executives are testing photo-cell control to see whether some of the increased lighting costs cannot be offset.

Increased power loads are anticipated by manufacturers formerly operating continuously who are now permitted only 80 hours' operation. Two plant executives have installed power factor correction equipment which they estimate will repay itself within a year through lower power costs.

All causes for reduced machine production because of faulty power transmission are being given consideration. Whereas, in a majority of cases, piecework operators were formerly penalized by waiting for repairs, the subject of machine-down time seemed relatively unimportant. The situation has changed, however, and it is to the absolute interest of industry to avoid every form of incidental machine-down time. Constantly re-used and patched belts cause considerable lost time. Faulty and re-used chain links will cause losses. Insufficient accessory parts often keep operators waiting unnecessarily for completion of set-ups.

Plant Cost Control—Codes have brought pressure for a great many preliminary manufacturing statistics. Such statistics, it is generally appreciated, will not be sufficient, however, for the intelligent routine control of labor costs, allowances made, and more specific data pertaining to the hours worked and pay earned of individual employees. Manufacturers located in areas where fines have been imposed for lack of code conformity have learned that oral statements unsupported by intelligible records place the accused in a defenceless position.

The analysis of employees falling below minimum wage should be focused in such a way that plant managers can readily ascertain the degree of allowances and proficiency by departments and the factory as a whole.

Time clocks and time-recording devices of the more modern types are absolutely essential. Some plant managers have in the past considered time clocks as neces-

GRAPHIC PORTRAYAL OF OPERATORS
BEFORE ADJUSTMENT FOR MINIMUM WAGE
PRESENTED AS TO EARNINGS AND LENGTH OF SERVICE

Average length of service : 3 years 4 months — Average earnings per hour : $0.193

Earnings per hour	0-3 months	3-6 months	6-9 months	9-12 months	1-1½ years	1½-2 years	2-2½ years	2½ years-Up		
0.26 – up					1	5	3	15	24	5.2
0.22 – 0.26	1			9	11	6	11	74	112	24.0
0.18 – 0.22	1		3	16	12	9	9	115	165	25.0
0.12 – 0.18	7	1	3	19	10	9	12	56	117	25.0
0.08 – 0.12	4	3	1					2	10	2.1
0 – 0.8	38	1	1						40	8.5
	Length of Service									
Number of employees	51	5	8	44	34	29	35	262	468	
Per cent of Total	10.9	1.1	1.7	9.4	7.3	6.2	7.5	55.9		100.

Figure 1.

sary evils, especially in piecework departments. Now clocks present the only practical and accurate method of controlling maximum hours, and ascertaining what, if any, allowances must be made. They supply the best supporting data in cases of stated infractions of the maximum hour limits.

Control statements, it is felt, must show more clearly what costs should be as compared with those actually incurred. Executives using standard costs have been in a position to gage the effect of the law upon the costs of their products. Such companies have modified previous operating statements so that the monthly effect of codes could be readily visualized. A sample statement of the type employed in more than 70 mills is shown in the "Manufacturing Budget Variation Statement" reproduced in Table I, page 410. It offers a manifold advantage to every plant executive during these times. It enables him clearly to gage the effect of various phases of his own controllable activity contributing to the total showing. It enables him to refer quickly to detail by departments that will give decided indications of supervisory, labor, and planning conditions. It gives him the basis for judging the broad progress made in controlling learners and avoiding minimum wage losses.

The reactions of several plant executives who control their manufacturing costs with this type of statement were interesting. One stated that standard costs aided his organization to revamp cost estimates for predetermining necessary price adjustments. Another stated that the full realization of the effect of the code upon costs would not have been felt for a considerable period if their old past-history unit cost system had been in effect. Several stated it would be a definite and quick guide in adjusting rate levels and training help to meet the new order of things.

Employee Relations—There has never been a period in the history of this country when industry required the absolute loyalty of its secondary line of supervisors more than it does today. Such loyalty cannot be expected to last indefinitely unless compensation is made in some measure for past salary cuts.

The executives contacted strangely enough classified their secondary supervisors as "Forgotten Men." It seems to be the consensus of opinion that foremen's wages are to be left where they were except where the rate is below the $35 minimum. However, executives with sufficiently broad vision are offering such groups the possibility of improving their earnings through keyman incentives for their performance in reducing minimum wage allowances and decreasing labor turnover.

The psychology of the day is "increasing wages" and "more people working," yet the attitude of most executives is to leave the wages of this group untouched, it being their thought that a further increase in fixed charges at this stage is not warranted. Those executives who anticipate reactions, who do not desire to increase fixed charges, and who have equipped themselves with proper supervisory incentives, are setting incentive standards on a more liberal basis. Such measures protect the company should volume fall, serve at the same time as an inducement for supervisors to redouble their efforts.

Inaccuracies in rate-setting methods may cause a series of difficulties. If operators are given tasks on which the incentive rates are low, they will simply sit back and wait for minimum wage allowances. On other jobs with excessively high rates, the company pays unearned bonuses, thereby losing out in both directions. It is extremely important that the basis for, and the method of calculating, new rates be accurate.

Executives in companies that have been paying considerably above minimum wages claim an injustice. They are required to boost the base rates by an amount equal to the decrease in working hours. A producer going from 50 to 40 hours with an average rate of 50 cents per hour in effect will have to increase costs 12½ cents per hour, whereas the manufacturer paying 30 cents per hour will increase his rates by 7½ cents only. If the differential is an essential handicap to competition and the high-rated employer is using a piecework system, it will become absolutely essential for him to abandon that method of payment. Simple standard-hour plans where rates are expressed in terms of labor hours and employees given base rates of pay will have to be substituted. Such plans

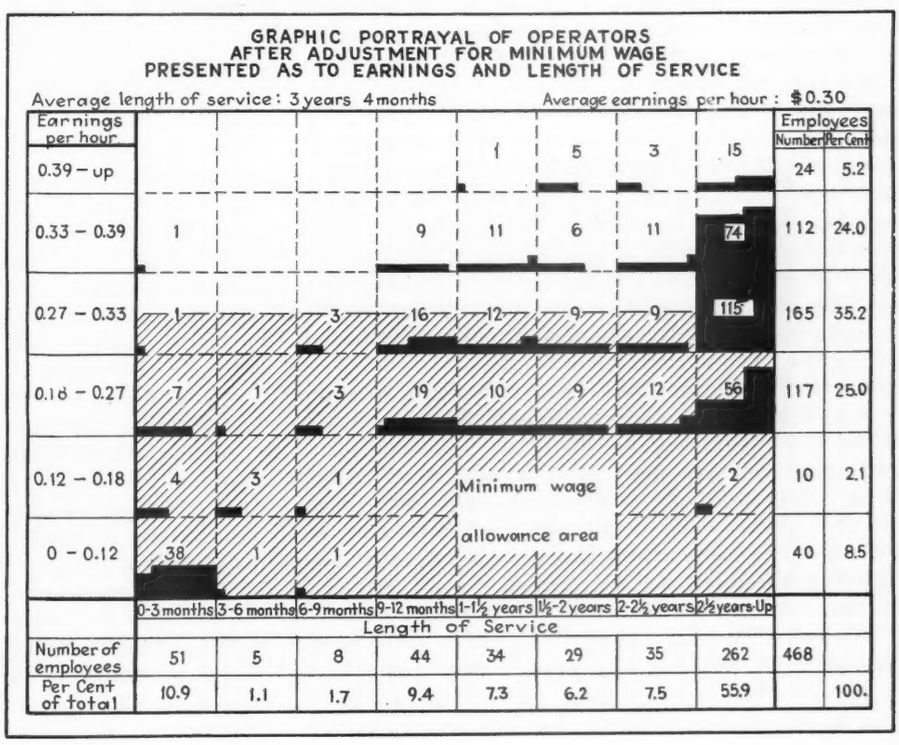


Figure 2.

TABLE I

Manufacturing Budget Variation Statement

Summary	Last Month Without Code	First Month Under Code	Year To Date
TotalStandardExpenses	$90,000.00	$110,000.00	$200,000.00
Total Actual Expenses..	102,000.00	124,800.00	226,800.00
Net Gain or Loss..	‡12,000.00	14,800.00	‡26,800.00
Detail of Variations			
Material			
Standard Value.....	58,000.00	71,000.00	129,000.00
Actual Value.....	57,500.00	69,500.00	127,000.00
Net Gain or Loss..	500.00	1,500.00	2,000.00
Substitutions (materials)			
Standard Value.....	6,200.00	7,300.00	13,500.00
Actual Value.....	6,400.00	7,600.00	14,000.00
Net Gain or Loss..	‡200.00	‡300.00	‡500.00
Labor and Overhead			
Standard Expense...	25,800.00	31,700.00	57,500.00
Actual Expenses ...	38,100.00	47,700.00	85,800.00
Net Gain or Loss..	‡12,300.00	‡16,000.00	‡28,300.00
Due to: Factory Responsibility			
Direct Labor			
Learners' Allowances	300.00	‡4,200.00	‡3,900.00
Rate Adjustments .	.....	‡6,060.00	‡6,060.00
Overhead Gain or Loss on Labor Efficiency	120.00	80.00	200.00
Indirect Controllable Labor.....	‡400.00	330.00	‡70.00
Departmental Supplies and Service.....	‡900.00	‡200.00	‡1,100.00
General Factory Controllable.....	600.00	800.00	1,100.00
Power Gain or Loss...	‡200.00	100.00	‡100.00
Due to: Administrative and Selling			
Volume Gain or Loss	‡8,100.00	‡6,000.00	14,100.00
Sample Expense.....	‡3,720.00	‡550.00	4,270.00

‡Denotes Losses.

will leave manufacturers in a more flexible base-rate position than with the rigid piece-rate system.

Some manufacturers who have been below the minimum wage have stated that the "minimum wage will be the maximum." In their first payroll experience, they stated that they would use the force system of telling employees who were below minimum that they would be subjected to discharge. In a few of these cases the expected reaction has taken place. The good operators who were only able to make slightly better than minimum lost their incentive upon seeing the laggards and inefficient help go out with minimum wages. "Why work hard for so little when you can loaf for so much," they say. The employer cannot enforce his threat because discharging help means training new help with a compounding of losses and potential labor troubles.

Interesting reactions have been received on the classification of skilled productive and unskilled non-productive labor. Floor boys working in thread conversion plants employing adolescent help have started grumbling over their classification. Some executives have gone to extremes in classifying helpers as "non-productive unskilled." The codes have been vague in the main in detailed classifications that will definitely place confidence in plant managers as to accurate classification.

Personnel Training—Most of the codes in the textile field state definitely how long a person may be considered a learner. Periods vary from four to ten weeks. A guaranteed rate is in effect. The combination of such relatively short learners' periods and the high learners' rates (in comparison with former pay) has created a temporary burden which industry can overcome only by reducing turnover and improving methods of selection.

In one company graphs similar to those shown as Figures 1 and 2 were plotted as a means of arriving at operators' learning periods, the number of employees under the average earning rate before and after pro rata increases to cover minimum wages. Reading the charts down the side indicates the earning classifications used and the number of employees in each range. Reading the charts across the bottom, the length of service and number of employees in each group are denoted. Figure 1 clearly indicates that 18 months was the approximate period required before an operator attained average hourly earnings. Should it continue to be necessary, with a six weeks' learners' period allowed, it would bankrupt the company. As a result, the company decided to place one instructor with every 30 operators instead of, as formerly, one supervisor to every 120 employees. Further analysis discloses a considerable number of employees on the border line of average earnings after 2½ years of service, whereas some were making top money in less than 15 months. This was simply a result of letting operators "sink or swim" and clearly indicated the need for more careful selection of workers followed by quick initial elimination, transfer, or training.

General Conclusions—The codes tend to permit or demand the following:

1. Standards of minimum wages and maximum hours.
2. Proration of volume to members of trade groups.
3. Establishment of prices based on reasonable costs.
4. Comparison of costs between members.
5. Cooperative, self-governing labor organization and representation.

They definitely discourage:

1. Predatory competition.
2. Employment of child labor.
3. Unfair and inequitable treatment of labor.

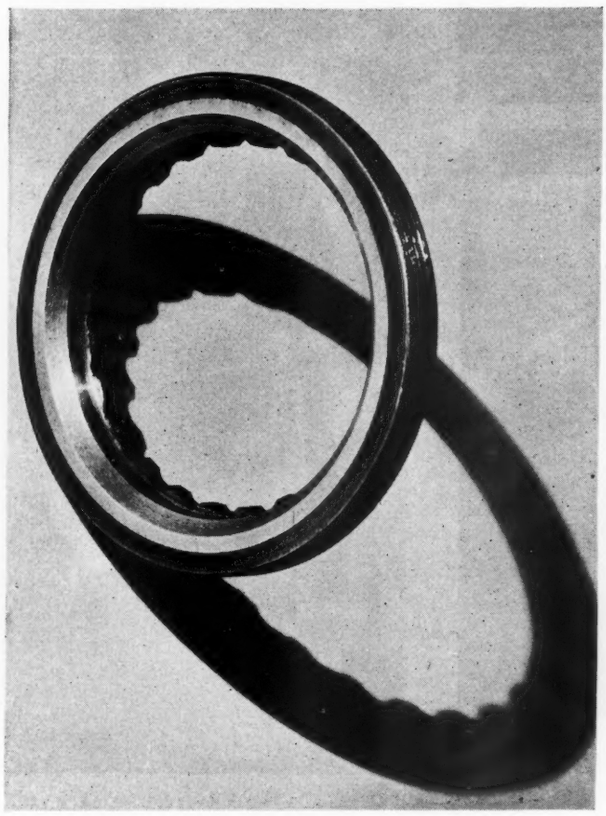
Companies will find themselves in positions depending upon their background. The low-wage, small-overhead manufacturer who cut prices and maintained volume on a price basis will have to change his line and his merchandising methods quickly or definitely pass out of the picture. The manufacturer with a high overhead, who pays considerably above minimum wages, may have real difficulties if it is necessary for him to sustain volume through competitive price work. The manufacturer paying very high wages, who was enjoying a low unit cost because of multiple machine operation, may be placed in a difficult position.

It will always be true, however, as long as there is a vestige left of our present corporate form of business, that there will be a premium on the company that can show the best return on the dollar invested. The new rules governing business will require every manufacturing executive to work to closer limits, and this need will undoubtedly challenge all of the available managerial skill of plant executives.

The codes are not intended to stifle initiative. The thought behind curtailing hours and paying former wages is simply a step in the direction of providing ample leisure for the rank and file to enjoy the benefits of a fuller life.

Where There's Wear—Try Hard-Facing

Profits can wear away; needn't if you protect parts subjected to abrasion



Hard-faced exhaust valve seats are good for 100,000 miles or more without regrinding

HARD-FACING is the process by which a layer of wear-resisting alloy in the form of welding rod is applied to a metal surface subject to abrasion, thereby giving protection to the surface which, under ordinary conditions, would be rapidly worn away. Hard-facing material is applied by a modified welding procedure, and the process has proved to be the economical answer to countless industrial problems involving abrasion.

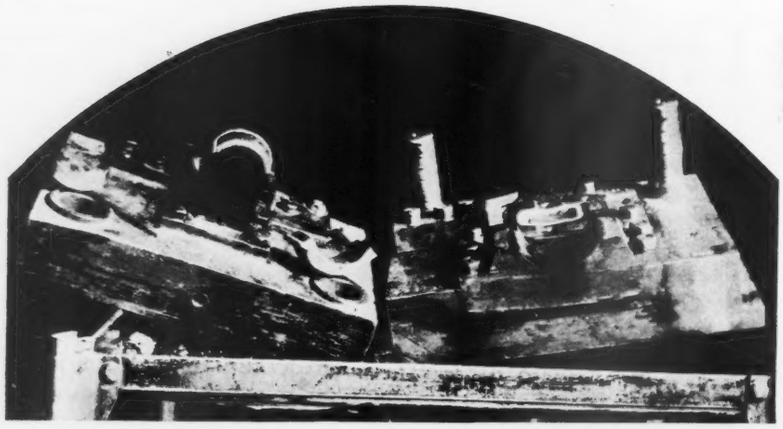
Whenever abrasion is encountered in industry, the life of the particular part subjected to excessive wear is shortened to less than that of the rest of the machine. Hard-facing those members receiving severe abrasive action materially increases their life. Fewer spare parts are necessary; idle machine time is decreased; production costs are frequently lowered; and greater over-all efficiency is maintained.

For instance, there are hard-faced exhaust valve seats for gasoline motors, one of the most recent applications of the hard-facing process. Because of higher compression ratios and faster speeds, the life of the ordinary cast-iron valve seat has been shortened to a point where its operation is no longer in keeping with the modern idea of engine efficiency. To reduce the wear, special alloy steel inserts have been designed which are faced with a wear-resisting alloy and are screwed directly into the cylinder-block casting. These hard-faced seats have resulted in greatly increased efficiency and economy. One large truck-fleet owner found that only three adjustments were necessary in 60,000 miles of operation with hard-faced valve seats.

One of the more spectacular uses of hard-facing is for airplane tail skids. Detailed reports from a western field with a granite surfacing showed that the life of an ordinary skid was approximately 40 landings. Skids faced with an alloy having an iron base lasted four times as long. Similar skids surfaced with a hard-facing alloy of cobalt, chromium, and tungsten were good for 400 landings. A skid made up with inserts of tungsten carbide and faced with a cobalt-chromium-tungsten alloy lasted approximately 800 landings. Thus it is possible to increase skid life 20 times by the use of hard-facing metals, at an increase in cost of only about 2½ times. When the savings in labor and time of making nineteen replacements are considered, the economy of hard-facing is clearly evident.

In manufacturing fields, the practice of hard-facing punches, dies, shear blades, cams, etc., has resulted in decided economies in many operations. Frequently it is possible to salvage an old die from the scrap heap, rebuild it, hard-face it, and put it back in service, where it will outlast a new die many times over. Practically all kinds of hot trimming and forming dies can be rebuilt with hard-facing material and used again and again, resulting in great savings through eliminating the necessity of scrapping many pounds of expensive alloy steels.

A Pennsylvania pipe company has found that hard-facing ring dies results in greatly increased life. These dies are used in the last stage of the finishing bench in the production of seamless steel cylinders and are subjected to extremely severe heat and abrasion. Former practice was to use chilled iron dies which produced from 30 to 40 cylinders each. These hard-faced dies now run from 200 to 825 cylinders before rebuilding is



Six hundred generator poles from high-speed steel dies; six times as many from dies surfaced with wear-resisting alloy

Sprocket teeth on this beet elevator will live longer when hard-faced

Flights of a cement screw conveyor last five times as long

required. Hard-faced dies in the first and second stages of the finishing bench yield as high as 2,000 pieces.

A Michigan manufacturer estimates that he saves $40 per day through the application of hard-facing material to a hot trimming die. A carbon tool-steel die averaged only 500 pieces, whereas hard-facing has increased its service life to 6,970 pieces. The actual cost figures for hard-facing this die inclusive of material and labor amounted to $14.87. Another feature of this job is that the steel used for the hard-faced die cost only one-third as much as the steel for the carbon tool-steel die.

Many savings have been effected by automobile manufacturers through the use of the hard-facing process. One manufacturer has obtained six times as many generator poles from a single die since adopting the practice of hard-facing these dies. The average life of hard-faced dies is 3,500 pieces, whereas high-speed steel dies last but 600 pieces. At this plant, the life of hot trimming dies for brake pedals has been increased to 14 times that obtained prior to hard-facing. Since it is possible to reface these dies time and again after the first application has worn off, the total saving resulting from this practice amounts to a very considerable sum of money.

A knitting company has found that hard-facing stitcher cams gives these parts greatly increased life. Only one month's service is obtained from new cams which cost $2.18 apiece. Old cams are built up for 38 cents, including the cost of hard-facing alloy and all labor charges, and the hard-faced cams last for six months before rebuilding is necessary.

Shear blades which are part of a machine for forging steel balls for ball mills have been successfully hard-faced. This machine cuts off stock and forges the balls at the rate of 60 per min. for 3-in. balls and 110 per min. for $\frac{3}{4}$-in. balls. The best steel shears run for but one day without grinding, whereas hard-faced shear blades give from 10 to 15 days' service before it becomes necessary to regrind.

The average life of hardened steel collets used in the production of roller bearings in a certain automobile plant seldom exceeds 14 hours. Experiments made with inserts of solid wear-resisting alloy showed that the life of these collets could be increased to 1,000 hours.

Innumerable minor applications have been found which, for a remarkably low cost, will lengthen the period of uninterrupted operation of equipment. Among

a list of typical examples should be included feed rollers, rest bars, guide blocks, automatic screw machine cams, clutch fingers and dogs, eccentric screws and keys, turret lathe chuck collars, lathe centers and guides of all types. Experience has proved that the life of many such parts will be economically increased by the addition of a few ounces of wear-resistant alloy.

Ordinary wire guides become too worn for use after 7 hours' service at a lock washer company, whereas hard-faced guides last 21 hours before rebuilding is necessary. At a spring and bumper company, hard-faced slides were still in good condition and showed very little wear after one year of service. Prior to hard-facing, these slides lasted but two months. The life of tool-steel centers for crankshaft turning and grinding has been increased from 1½ to 9 days by hard-facing them at a total cost of 28 cents, including labor and material.

Materials used for hard-facing may be generally divided into four classes. The first comprises alloys relatively low in price, such as white iron; the second consists of alloys with an iron base and containing appreciable amounts of carbon and such elements as chromium, tungsten, manganese, silicon, and sometimes cobalt and nickel; the third is composed of non-ferrous alloys, such as cobalt-chromium-tungsten alloys; the fourth class consists of the so-called diamond substitutes, which are essentially cast tungsten carbide.

The first of these classes is used only where the wear is slight. The second class of materials may be used under conditions of moderate abrasive wear. The diamond substitutes in the fourth class have an extremely high melting point and cannot be applied like welding rods. They are accordingly used as inserts of grains of various sizes embedded in a binding material which is welded to their surfaces, holding them in place so that their superior wear-resisting properties can be utilized. The non-ferrous alloys of cobalt, chromium, and tungsten give maximum wear resistance and especially resistance to abrasion at elevated temperatures. The most important property of hard-facing materials is their hardness, and alloys of this third class are not only inherently hard without heat treatment, but retain their hardness extremely well up to a red heat.

The ease with which hard-facing materials may be applied, coupled with the greatly increased life of the parts given this treatment, has led to the establishment of this process as standard practice in many industries. But there are doubtless hundreds of new applications on which this process could be used for effecting maintenance and operating economies. A careful study of the conditions encountered and an investigation of the properties of hard-facing metals may lead to the saving of thousands of dollars through prolongation of the life of wearing parts and consequent reduction of idle time.

▼ ▼ ▼

Maintenance Cost Control

V—Control by Budget

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CONTROLLING maintenance costs by a budget embodies this principle—a thorough consideration is given beforehand of the maintenance work recommended, decisions are made as to what is to be done within the budget period and what that work should cost, and every effort is made by those responsible for the costs to complete the work within the allowance which they themselves agreed could be met.

The theory embodying the budget method is simply the principle established by the general scientific method, which is that if thought is given to a problem beforehand and a complete plan of action is outlined before the work is started, better results will obtain than if the problem is not thought through before the actual work is started. In outlining a budget method of control for maintenance costs, the following benefits may be given; they also indicate the theory:[12]

1. It saves the executives a great amount of time during the year, considering first one problem and then another, and concentrates a large part of this work in a few weeks, with the full advice and discussion of all those with experience, with all the details and costs thereto fully prediscussed.

2. It brings to the finance department the total amount of money necessary for this expenditure, considerable in any plant keeping up-to-date in these progressive days.

3. It substitutes for occasional and often individual thought the definite and total thought of the organization.

4. It gives system, plan, and scientific management to

a large problem most often haphazardly, and too often laggardly, handled in many plants.

Another outline of budget control system expresses its benefits as follows:[13]

1. It enables management to limit departmental or plant activities without restraining the business.

2. It gives all concerned an opportunity to plan for the future.

3. It is a deterrent to unbridled and extravagant expenditures; in the end assures profits and dividends for owners. It will not insure profits, but is about the only means at hand to forecast what the condition of the plant will be.

The budget method of maintenance cost control has, as the basis for establishing maintenance standards, the policy of management toward maintenance. The modern policy toward maintenance considers the four elements stated below:[12]

1. Running repairs, which under all conditions are necessary for a going plant.

2. Replacement of machinery, equipment or even buildings, that are slow, ill-balanced, obsolete, or poorly arranged for an economic balance.

3. Addition of improved appliances, rebuilding or redesigning equipment for better or more economical production.

4. Finally, increased production, if it should seem wise or essential, and the necessity it involves in planned expenditure.

The same general procedure holds in all factories of all industries. One person of the organization is held responsible for carrying the work through to completion; the plant engineer is the logical member to do it. Each department head submits a report to his superintendent of his department's requirements during the next budget period, listing the items under repair and replacements, and new work. Each superintendent scrutinizes the reports of his foremen; when all is satisfactory to him, he passes them to the person in charge of the maintenance budget. All of the reports are now consolidated into two folders, repairs and replacements, and new work.

The next step is to discuss the proposed work. The members of the factory organization present at the discussion vary in number—all foremen and up in some plants, major executives in others. However, if the discussion can be guided properly, the farther down the organization it goes, the better the spirit developed with which to carry out the final adjusted program. Each member wants to feel that his ideas have been considered fully.

When the discussion has sifted out and decided upon the work to be done, and when costs have been estimated, the budget is submitted to the executive in charge of factory operation. After it has been further adjusted to meet his approval, it is signed and becomes the standard of performance for the maintenance division during the ensuing period.

The discussion considers the necessity, the advisability, and the financial obligations of each item. For running repairs the costs of previous years are taken to gage the amount budgeted. Replacements, improvements, and additions are considered on the basis of what improvements of quality, of quantity, or economy of production they will effect, and how long such improvement will take to liquidate the cost, or what return on the investment each will bring.

Actual applications of the budget method are quite similar, varying only in the size of the discussion group, and the plan used to rate the maintenance division in its effectiveness in meeting the predetermined standards of performance. However, a few applications will be noted. A paper company includes all department heads in the budget discussion, and a monthly list is sent to all concerned showing budget amount, cost, and total cost to date for each department compared with the budget.[12]

A shoe company operates its maintenance on schedule and budget. Each item is scrutinized, and when excessive time is charged to simple repair jobs, the department is reduced by one employee. A weekly balance sheet is prepared and compared with the amount budgeted, which is reduced to a weekly basis. The increase or decrease per week is recorded, and is a factor considered in setting the next year's budget.[14]

A can company compares its actual costs and its budget each month. The budget is made for a year, and is not changed during that time. If an extraordinary expense not budgeted occurs, authority is asked for and, if approved, the expense is carried to the end of the year to be charged off. This practice eliminates budget revisions and much red tape is avoided thereby.[13]

A company manufacturing motors and electrical appliances has developed a sliding budget. The amount allocated to each maintenance expense is plotted on a basis of departmental loading, starting from 30 per cent capacity. As the volume of business fluctuates, factory instructions are issued to operate at a specific capacity basis. The executives affected are given 60 days to make necessary adjustments.[15]

A department store makes a major expenditure sheet itemizing the cost of all major jobs to be done during the fiscal year. This sheet does not include regular maintenance. In addition a monthly salary budget is made up one month in advance. This includes major jobs as well as regular maintenance work which will be performed in that period. The estimates are based on past experience and present conditions.[16]

[Mr. Zinck's sixth and concluding article, scheduled for November publication, will describe a third method of controlling maintenance costs—by time allowances on individual jobs, with a check on total expenditure.—Ed.]

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[12] "Budgeting Upkeep Keeps Down Expenses," B. A. Franklin, vice-president, Strathmore Paper Company, Mittineague, Mass., *Industrial Engineering*, December, 1929 (pages 622-623).

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[13] "Maintenance Budgeting," J. L. Kirsch, general plant engineer, Continental Can Company, Chicago, Ill., *Industrial Engineering*, March, 1930 (pages 164-165).

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[14] "Maintenance by Schedule and Budget," C. H. Brechner, chief engineer, Selby Shoe Company, Portsmouth, Ohio, *Industrial Engineering*, November, 1930 (pages 556-559).

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[15] "Maintenance Operation," E. C. Brandt, works manager, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., *Industrial Engineering*, March, 1930 (pages 167-169).

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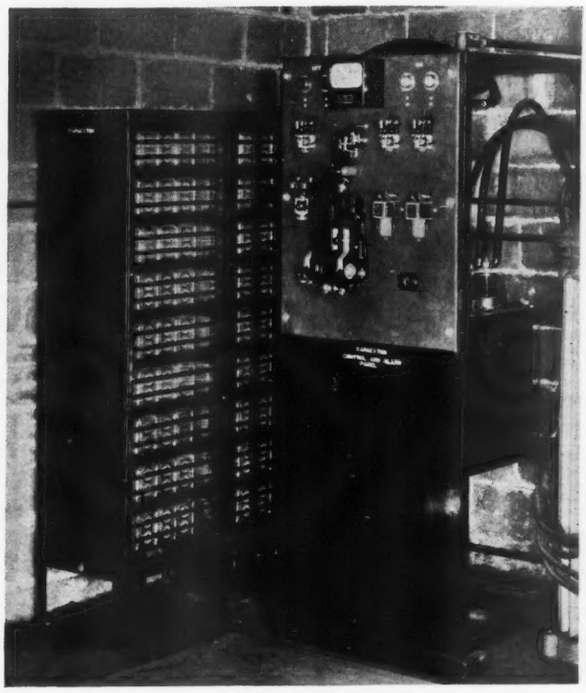
[16] "How Measure the Efficiency of the Maintenance Department?" L. H. Dickelman, building superintendent, Ed. Schuster & Company, Inc., Milwaukee, Wis., *Maintenance Engineering*, September, 1932 (page 363).

Power Survey Earns $2,000



Saves $1,800 a year. This bank of 135 1-kva. capacitors raised power factor from 65 or 70 per cent to 99 per cent. The control panel indicates when the bank is on the line, automatically gives audible and visual signals when it goes off. An auxiliary alarm panel is located in the basement of the main plant

Allen K. Wolfe

Engineering Department
Allen-Bradley Company, Milwaukee, Wis.

IN ANY industrial plant that uses considerable amounts of electrical energy there is likely to be appreciable wastage. Changes in loads and processes, addition or removal of equipment, and other factors may easily tend to lower the efficiency of energy utilization. Recently a thorough survey of our plant was made to determine the proper size of motors for the different applications, the power factor of the motors, the feasibility of installing power factor corrective equipment, and the possibility of reducing the maximum monthly demand peaks.

Power is purchased from the local utility, enters our substation at 13,200 volts, three-phase, 60 cycles, and is distributed through five transformers:

1. Shop and test floor, 400 kva., 13,200/244 volts, three-phase, 60 cycles, located in substation.

2. Lights, 300 kva., 13,200/122 volts, single-phase, 60 cycles, located in substation.

3 & 4. Test floor, 200 kva., 13,200/540 volts, three-phase, 60 cycles, used in conjunction with a 200-kva. booster auto-transformer supplying 440 and 550 volts, three-phase, 60 cycles, located in substation.

5. Electric furnace, 400 kva., 13,200/240/120/60 volts, single-phase, 60 cycles, located in furnace room.

Energy consumption is measured on the primary service by an integrating kilowatt-hour meter with attachment to record demand in 15-min. intervals, and a reactive component meter which registers the amount of reactive kilovolt-ampere hours.

According to our power contract, the demand rate for unlimited service is $2 a kilowatt a month for the first 200 kw., and $1 a kilowatt a month for off-peak service. In excess of 200 kw. a month, the charge is $1.50 a kilowatt a month for unlimited service, and 75 cents for off-peak service. The demand charges are based on a combination of these two types of service.

The contract provides that "10 kw., designated as 'Unlimited Service,' shall be available continuously, including the on-peak hour periods for customers' use, and the remainder, designated as off-peak service, shall not be used during the on-peak hour periods, which are from 4 p.m. to 7 p.m., Monday to Friday inclusive, during the period October to March inclusive. The measured maximum demand shall be determined by the maximum rate at which energy is used for any period of 15 consecutive minutes."

Our peaks occurred between 7 a.m. and 9 a.m. It was found that our electric ovens, started at 6 a.m., did not reach normal operating temperature until an hour or more after the plant started. Further investigation showed that the oven heaters are on the line only one-fifth of the time after the operating temperature is reached—that is, they are thrown on 15 sec., and off 60 sec. automatically by thermostatic control. By starting the ovens sufficiently early to have them up to operating temperature before the plant load comes on at 7 a.m., a considerable reduction in the peak demand was effected, at a saving of $48 a month.

Any reduction in peak demand is important, because the maximum demand upon which the monthly charge for power service is based is designated as "Billed Demand," and equals the measured maximum demand times 0.80, divided by the monthly average power factor. The rate schedule is based on a monthly average power factor of 80 per cent. The total billed demand combination of "unlimited" and "off-peak" service shall not be

less than 75 per cent of the highest billing demand during the preceding eleven months.

In other words, if we had a billed demand of 600 kw. in November, 1932, and a billed demand of only 325 kw. in March, 1933, we would be required to pay for 450 kw. (75 per cent of 600 kw.), or a penalty of $93.75 for the month of March alone.

In addition to the demand charges there is, of course, an energy charge ranging from 1.25 cents to 0.70 cents a kilowatt-hour, depending on the amount consumed during the month.

Our first step was to analyze the power bills and the meter charts for the preceding two years, from which we found that the billing power factor averaged between 65 and 70 per cent, and that the maximum demand varied from 325 to 600 kw., with the average about 475.

Then the location of each motor, with its complete nameplate data, with the machine driven, was listed on a special test sheet which contained space for recording voltage, current, kw., kva., per cent power factor, and load conditions.

We operate 365 three-phase, squirrel-cage motors, ranging in size from ¼ to 50 hp., aggregating 825 nameplate horsepower. Most of the plant machinery is individually motorized, the lineshaft drives being confined to small groups of punch presses, screw machines, and the tool department machinery.

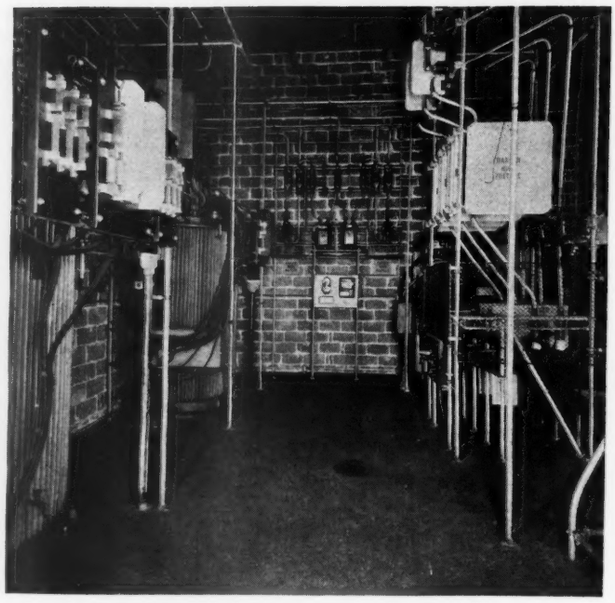
In obtaining the test data on the motors we used one three-phase indicating wattmeter, complete with two current transformers (adjustable tap type, ratios 25:5, 50:5, 100:5), two ammeters, two voltmeters, and one of our bulletin 609, size No. 2, manual switches. This equipment was mounted on a portable hand truck.

After concluding the tests on the motors it was found that the power factor varied from 25 to 92 per cent, with an average operating power factor of around 60 per cent. The power factor of the individual motors was calculated from the wattmeter reading divided by the product of the voltmeter reading times the ammeter reading times 1.73.

Reasons for these low power factors are: (1) Many small squirrel-cage motors, and some in the larger sizes, have inherently low power factor; (2) numerous applications were over-motored because (*a*) larger motors than required were installed in anticipation of increased loads that never materialized, (*b*) manufacturing methods were altered so that actual load decreased over the original application, and (*c*) stock motors taken from machines that had become obsolete were applied on new machines, even though of larger rating than required.

How low power factor of a motor, due to poor design, affects power costs, can be shown by the operation of a 25-hp. motor running 200 hours a month, fully loaded, drawing 22.8 kw. (energy power) at a power factor of 70 per cent. A well-designed motor of this rating would have a full-load power factor of about 88 per cent. On the basis of monthly power bills it was estimated that the plant power factor would have been increased 0.3 per cent a month if a motor with the higher power factor had originally been installed. This would mean a yearly saving in power charges of $37, or $148 for the four years that the 70 per cent power factor motor was operating.

A further saving was made by interchanging two



Purchased power enters the main substation at 13,200 volts, is stepped down to the voltage required for the different services by the transformers. The capacitor bank, not shown here, is at the extreme left

motor-generator sets on the test floor. Formerly a 50-hp. set ran continuously to supply direct current for our test floor and one or two production departments. A 20-hp. set was used only when more capacity was required. Recently the d.c. power requirements for manufacturing purposes have decreased considerably, so that the smaller set has ample capacity for the average requirements of the test floor also. By using the 20-hp. set for the everyday requirements, and keeping the 50-hp. set in reserve, it is estimated that a yearly saving of $150 will be made.

The next consideration was the improvement of the plant power factor. Because of the large number of small motors, and the fact that there were only two relatively small applications where synchronous motors could be substituted, use of capacitors was clearly indicated.

Serious consideration was given to correcting the power factor of the individual motors, as compared with complete plant correction, by means of capacitors. In one case installation of a 5-kva. capacitor at the motor terminals would save approximately $81 a year. In another case there was the possibility of installing an 18-kva. capacitor and saving about $170 a year. With the two installations the total yearly saving would have been only $194, because the corrective effect is additive vectorially and not arithmetically. This brings to light the interesting fact that it would require about one and one-half times more capacity to correct our power factor from 85 to 100 per cent than would be required to raise it from 70 to 85 per cent.

To correct a 70 per cent power factor circuit to 85 per cent requires approximately 40 per cent of the real power rating in corrective reactive kva., whereas to correct from 85 per cent power factor to 100 per cent requires about 60 per cent of the real power rating in corrective reactive kva.

It was decided to install a 135-kva., 242-volt, three-

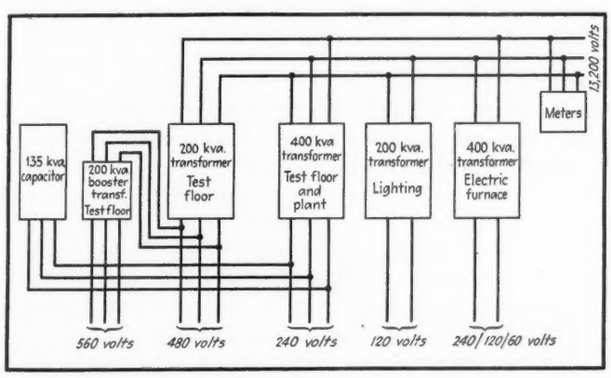
phase, 60-cycle bank of capacitors consisting of 135, 1-kva., single-phase, oil-immersed, vacuum-treated, individually fused units. They are mounted in an inclosed rack, fifteen in each row, nine rows high. The capacitor terminals face the front of the rack and are connected together to form a three-phase delta connection, with the necessary discharge coils. This method of assembly makes the units easy to inspect and accessible for removal.

For the capacitor bank a full automatic control and alarm panel was installed in the substation, and a separate auxiliary alarm panel was located in the basement of the main plant. On the main control and alarm panel are mounted:

One three-pole automatic oil switch.
One pilot-circuit, solenoid-type relay, to handle oil switch coil current.
One Off-and-On lever switch providing two-wire, low-voltage-release control.
Two quick-tripping, magnetic-type, oil dashpot overload relays, with coils connected in secondary circuits of two current transformers.
Three 100-1 ratio current transformers, one in each phase.
One 500-amp. indicating ammeter, in secondary of current transformers.
One three-phase test jack and plug, for current readings in each phase.
Two Off red indicating bullseye lamps.
Two On green indicating bullseye lamps.
One 240/110-volt alarm circuit transformer.
Two alarm circuit, solenoid-type relays with current coils energized from secondary of current transformers.
One alarm gong, with 110-volt coil.
One set of control circuit fuses.
One set of alarm circuit fuses.

The separate auxiliary alarm panel in the basement contains two Off red indicating lights, and one alarm gong Stop button.

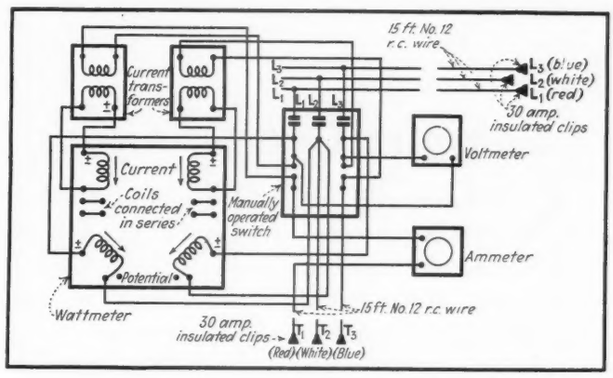
Normally the capacitor oil switch is closed, and the current coils of the alarm circuit relays are energized, lighting the green bullseye lamps, which give a visual indication on the main control panel that the capacitor



The capacitor bank is connected across the main distribution transformer, which supplies the test floor and manufacturing departments

is on the line. If the capacitor becomes disconnected, the alarm circuit relay coils are de-energized, opening the circuit to the On green lamps and lighting the Off lamps on the main control and auxiliary panels. At the same time the alarm gong rings, so that there is audible and visual indication that the capacitor is not operating. The alarm gong rings until the Stop button is pressed. The Off indicating lights on both panels remain lighted until the capacitor has been put back on the line.

The value of an alarm circuit was shown by a recent mishap with a capacitor bank and control that are isolated from the plant. Momentary voltage failure caused the manual oil circuit breaker to open. This condition was not discovered until receipt of the power bill the following month. It was then noted that the power



Connections of instruments used in testing motors. Ammeters and wattmeter current coils were connected in place of the thermal overload relay elements of the switch. Corresponding line and load terminal clips were colored red, white, and blue, respectively, to avoid interchanging leads and reversing the motor. With small motors the test switch was shunted around the motor starting switch. For large motors the load terminals were disconnected at the starter, the testing outfit was connected in, and the motor started in the usual manner

factor was 60 per cent instead of the usual 100 per cent, showing that the capacitor had been out for the entire month.

Assuming a demand of 400 kw., at 60 per cent power factor, the billed demand was 534 kw. against a billed demand of 320 kw. at 100 per cent power factor, representing a difference of 214 kw. at 75 cents a kw., or a penalty of $160.50. It also meant that a minimum billing demand of 400 kw. (75 per cent of 543 kw.) was established for the next eleven months, imposing a penalty of 80 kw. a month at 75 cents a kilowatt. This amounts to $60 a month, or $660 for the eleven months, plus the $160.50, or a total penalty of $720.50 for that one month's condition. The utility company made some concession in this particular case, but the point is that a small alarm panel would have more than paid for itself on this one occasion.

Since installing the capacitors our billed power factor has been raised to 99 per cent, effecting a saving of $150 monthly.

Another saving is being effected automatically because the 400-kva. distribution transformer, formerly loaded to 450 kva. at times, will now be relieved from supplying part of the magnetizing current, so that under the same conditions as before, when it was loaded to 450 kva., the load will be 360 kva., or 20 per cent less. Therefore, increased power capacity is provided with the same equipment, and the necessity of purchasing an additional distribution transformer has been eliminated.

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

OCTOBER, 1933

Consider Capital Goods

NRA attention to the capital goods industries is past due. To date 99 per cent of recovery emphasis has been directed toward consumer goods industries. Yet what we are combating is a capital goods depression.

In the consumer goods industries, operation throughout the depression receded from 25 to 30 per cent. In the capital goods industries it receded from 67 to 75 per cent, is not far above that level now. Yet the making of capital goods (meaning here "durable goods," in contradistinction to the relatively short-lived consumer goods) normally provides 50 per cent of the country's industrial employment.

On the part of Washington there has been lack of expressed appreciation of the need for betterment in the capital goods industries. Fostered by statements averse to new equipment made during the hearings on the Textile Code; by the wording of the Public Works section of the bill, looking toward the selection of labor-laden projects; by proposals on the part of some industries, aimed at the prevention of further capital expenditure, there has evolved a widespread conviction that is pernicious. This conviction is that to refrain from replacing obsolete or inefficient equipment by cost-cutting equipment is meritorious; that to do things by man power instead of machine power is in the interest of increasing employment.

Any such back-tracking policy is erroneous. If carried to absurdity, it would place us in the position of trying to live without tools. The process of reversion involves progressively increasing the cost of everything, with continually lowered standard of living—placing a premium on inefficiency, penalizing good management, technological development, social improvement.

Encouraging news comes from Washington in the announcement that a special section has been set up, under the Research and Statistical Division, headed by Dr. Alexander Sachs, in which a study will be made to determine what can be done with reference to the durable goods industries.

Although no definite statement in reference to equipment and capital goods has been made, the demands of the situation, according to NRA economists, are imperative. It is pointed out that while the codes do not put any obstacles in the way of the replacement of old equipment, there is a definite tendency in some of them to penalize enterprise even in replacing old machinery, and this tendency must be stopped, if the most productive section of American industry is to have its chance to contribute to the general prosperity.

If the new section, under Dr. Sachs, follows Administration precedent, it will get some place, and rapidly. But much time has been lost; much slack must be taken up. There is where the individual plant can help. Let it search for cost-cutting methods in all seriousness; produce at the lowest possible cost, in the interest of widest distribution; take advantage of modern equipment in doing so.

What Others Think

THE NECESSITY for restoration of the capital goods industries is recognized in all its seriousness in many quarters. Say that the industries concerned make "capital" goods, or "durable" goods, or "heavy" goods, as you like, but at any rate attend the statements from the several points of view represented in the quotations that follow:

Banker

HOWEVER greatly the purchasing power of factory workers, clerical employees, and farmers is increased, they will buy only a part of the industrial output, to wit, consumer goods, such as food, clothing, domestic fuel, and, as their means permit, automobiles, implements, and other durable goods of individual use. The remainder of the industrial output is that purchased by the industries themselves, i.e., capital goods, such as machinery and tools, construction materials, railway and other

transportation equipment. No recovery could go very far without including these goods, which normally make up about one-half of the business of the country.

It is the capital goods industries, and the more durable types of consumer goods, which decline most in a depression, and usually advance most in a recovery. In fact, the evidence is that very little decline in the physical volume of articles of everyday consumption occurs even in a depression as severe as this.—*National City Bank of New York.*

Economist

LET US remember that the focal point of the industrial depression lies not in the consumer industries, in textiles and boots and shoes and such goods. They are doing very well indeed. The deep depression is in the capital goods industries, in machinery and in construction. If we are to bring new purchasing power into the markets in truly impressive volume, it is absolutely essential that the capital goods industries should be expanded.

For from this point of view there is a great difference between, let us say, the textile industry and the capital goods industries. The textile industry cannot keep going unless goods are continually bought and used up, and that means that production must keep pace with immediate purchasing power. But capital goods industries, replacement of machinery, new machinery, building, and public works not only employ labor which buys textiles and other consumer goods, but produce products which do not immediately have to be sold and used up. They create effective purchasing power faster than production of consumer goods, and the more far-reaching and long-term the projects, the greater the effect.—*Walter Lippmann, in New York Herald Tribune.*

Deputy

I HAVE noticed with considerable surprise and dismay the attitude of many business men who are writing into their codes a degree of control and regulation of their affairs which would lead one to believe that they are glad to turn over to the Administration the responsibility for the operation of their businesses.

I have seen suggested codes in which industries have agreed not to purchase new equipment without a certificate of approval from the President of the United States. I have seen other clauses almost as ridiculous, which would place a premium on high-cost manufacturing and which would effect a moratorium on plant modernization, so important in our economic life. While it is necessary in some cases to control the increase in plant capacity, it is economically unsound to discourage generally the purchase of new, modern machinery.

I have been forced to the conclusion that many business men totally misunderstand the purpose of NIRA, or else they have taken such a beating in the last three years that they are ready to turn over to the Government responsibility for their business welfare.

I have been asked a number of times if the New Deal will stifle business initiative. My answer is, definitely no—unless business so desires. In fact, I see in this new scheme of things a challenge to our inventive genius, a greater opportunity than ever before for the development of new products, to be manufactured by new low-cost processes, to be bought by the great new masses of purchasing power.—*Malcolm Muir, Deputy Administrator of the NRA (President, McGraw-Hill Publishing Company).*

Professor

ASIDE from the heavy, durable items, the physical volume of final consumption is always well maintained during a depression; the decline in sales is almost wholly a price decline. . . .

The decline of business activity that takes place in a period of business depression is primarily related to capital goods, not to consumer goods. Stimulation of consumption by final consumers is very far from being the answer. The answer lies rather in the direction of resuming normal investment in the capital goods industries.—*Prof. Malcolm P. McNair, Harvard School of Business Administration, in Daily News Record.*

Editor

DEPENDING on definitions, the production of capital goods declined from 67 per cent to 75 per cent during the depression while the recession in the production of consumers' goods was somewhere between 25 per cent and 30 per cent. At the present rate of recovery, consumers' goods production will have recovered half its losses by the end of the year while capital goods will have recovered but about one-fifth. If consumers' goods be defined as those goods that go quickly to retail distribution and are consumed or worn out in a short time, we produced about 30 billion dollars of them in 1929 as compared to 40 billion dollars of capital goods.

The restoration of capital goods industries does not and should not depend on the inflation of plant capacities. Billions of dollars are needed immediately for the modernization of industry. Instead of curtailing employment, this modernization would increase employment. For every worker unemployed and every dollar of payroll lost in the capital goods industries, three workers are dismissed and $3 are lost to other industries which supply consumers' goods or industrial materials. It has been estimated that there is a backlog of 30 billion dollars of business required for the reequipment of industry. The figure is an accumulation of deficits which to some extent depend on definitions, and is probably excessive. The critical need of consideration for the capital goods industries is amply illustrated

by the fact that in the last three years there has accumulated a deficit of some 6 or 7 billion dollars in urgently needed plant facilities.—*The Business Week.*

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For Hard Drives

OUT OF the many advances made in motor design, two—the inclosed motor and the geared motor-reducer—should be kept in mind whenever a new application is considered.

Inclosed motors, on the market for several years, are widely used; ought to be more so. When local conditions are reasonably good, open-type motors will serve satisfactorily. Unfortunately, many motors have to operate where so much dirt, corrosive fumes, or water is present that the life of the open type would be measured in months or weeks. In such places a suitable form of inclosed motor will cut maintenance costs and production delays.

Geared motor-reducers, comparatively new, sturdy, compact, are often the simplest solution to the problem of getting the right combination of speed and power in small compass. Aside from the advantages they offer on direct-connected drives, geared motor-reducers afford a convenient means of simplifying belt drives by providing for an initial reduction in speed that might be difficult to obtain with belts alone. Again, when changes in speed are required from time to time, they can be secured easily by selecting the proper combination of driving and driven pulleys, if the output speed of the motor-reducer is anywhere near the average or mean speed desired.

In these two developments may lie the answer to some of your problems.

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How Old Is a Plant?

"SOMEBODY round here is a mighty good housekeeper."

It wasn't more of the old soft soap. We meant it. The plant manager had us down in the basement looking at some conveyors in the receiving room.

"Just how old do you think this plant is?"

"Oh, maybe five years," was our guess.

"Seventeen," said he.

Which leads us to remark that factories are only as old as they look. Does your plant look its age?

Re-Enters Quality-Buying

AFTER "price-buying" follows "quality-buying." Measurement by price alone is a kind of fever, induced by reaction of depression upon the subconscious. Industrial buyers are afflicted in direct proportion to their own reductions in sales. They buy to hold outgo to income, with a prayer that what is bought will last "until business is better."

A few unfortunate experiences with low-priced products that are also low in quality kick the pendulum the other way. Equipment failure, delayed deliveries, high maintenance expense, customer dissatisfaction cause a bitter taste. Re-enters quality-buying.

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For Fewer Fires

EVERY week, so far as we are concerned, should be Fire Prevention Week, yet we are glad to record that the week of October 8 has been set aside by the National Fire Protection Association for the dissemination of information which will lead to the establishment of proper safeguards against loss of life and property by fire.

Industry today is under terrific pressure. It must adjust itself to drastic changes of a nature never before contemplated. Does the simple matter of fire prevention and protection enter into that complex picture? It does. Industry's biggest job, after all, is to put people back to work. Fire is one of the very best ways of throwing them out of work.

Fire is too often looked upon as an Act of God. With too much reliance on the vigilance of workers and watchmen, coupled with faith in fire departments, not enough trust in built-in controls, industry is much like the American tourist who looked down into the fiery crater of Vesuvius, admitted it was some conflagration, but allowed his home-town fire department could put it out in a jiffy. What he neglected to consider was the fact that a well-designed sprinkler system might have smothered the tiny flame that started the whole thing.

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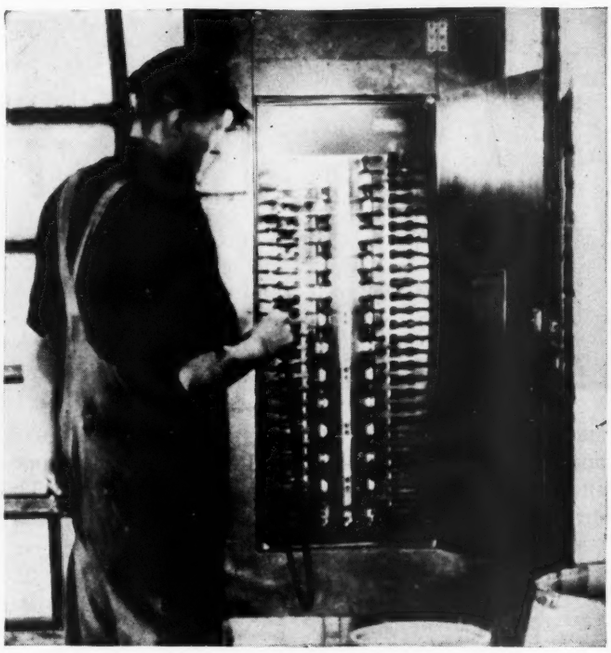
SAFETY TIP: Job analysis tends to remove motions that cause accidents.

SHORTS FOR MANAGEMENT FOR MAINTENANCE



Using the Pilot Lamp for Fuse Testing

A. A. A. Rodrigues, Maintenance Electrician
Candy Headquarters, New York, N. Y.

Pilot lamps, one of which usually is located in every light and power panel, make excellent and convenient fuse testing outfits. They are permanent fixtures and their use eliminates the necessity for test lamps which often are inaccessible or mislaid when needed.

The following procedure is necessary to adapt the lamp for testing: The pilot lamp generally is connected to the last, or second to the last switch at the bottom of the panel. After this switch has had its fuses removed, it is tied open to avoid accidental use. Then a flexible duplex cord, long enough to reach all fuses, is attached to its binding posts. The contact or touch ends of the cord should be twisted tightly and dipped in solder, and the braid covering of the individual leads should be wound with black cotton and treated with shellac.

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How Good Is the Product?

Arthur Van Vlissingen, Jr., Chicago

Inspection which really grades the product on a numerical scale is unusual. It has really great advantages, however, as the factory manager of the Foulds Milling Company, Libertyville, Ill., points out. Numerical grading, when accurately performed, accomplishes all that go and no-go inspection can do, and at the same time gives a close control on the quality being produced. For example, if 85 is set as the minimum quality which may be passed, it is nevertheless important to know whether the plant is turning out all of its goods barely above 85 or whether they average high in the 90's. Obviously, the closer the product runs to 100, the better chance it stands in today's competitive markets. And any tendency to lower quality—perhaps arising from some undetected deterioration of a machine, or to carelessness of an operator—is immediately caught, before it drops to the point where is causes spoilage and scrap.

Products of this plant are the so-called alimentary pastes—macaroni, spaghetti, egg noodles, and related goods. Finished product inspection comes through removing from the packaging lines every fifteen minutes a package of whatever product is running at the moment, and sending it to the laboratory for grading.

In the laboratory the inspector has a home-made fiber box, divided into five compartments the length of the product. She picks up the product—say spaghetti—stick by stick, inspects it, and sorts it into the section where it belongs; these are respectively 100, 90, 40, 20, 0 per cent. When she has sorted the entire box she counts the sticks in each compartment and thus by averaging has an absolute mathematical determination of quality. This figure goes into the records and reports to the plant management.

•

A hospital keeps one of its rooms down around freezing, dries linen with warm air generated by the condensing part of its refrigerating machine.

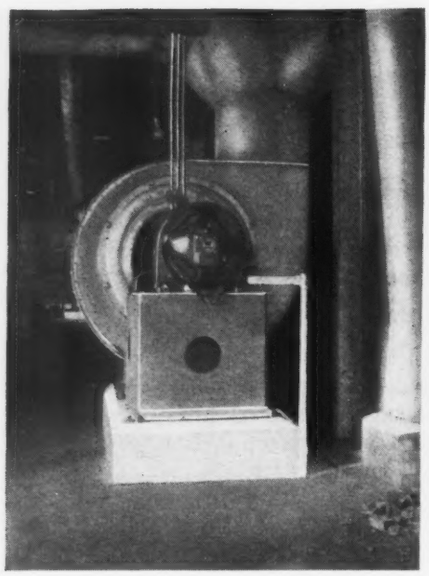
•

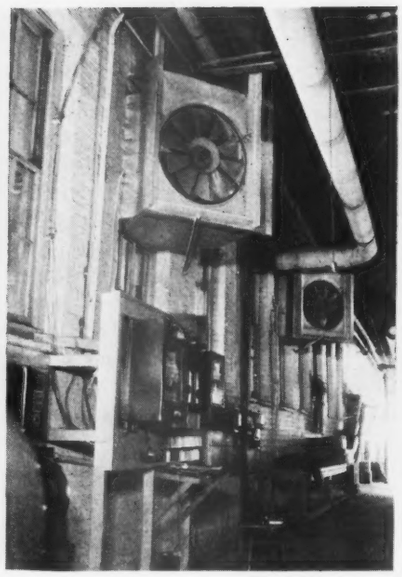
Waste Heat Utilized Space Reclaimed

To take care of increased production, the Star Porcelain Works, Trenton, N. J., installed a continuously operating, oil-burning tunnel kiln. In addition to facilitating production, this kiln solved the plant heating problem. Up to the time of installation, labor, fuel, boiler insurance, and other expenses of the heating plant amounted to $17,000 a year. Now the waste heat from the kiln is used to heat the entire plant. Three blowers, operated by a total of 23 hp. in motors, distribute the heat through a duct system.

The plant is two stories high, with 102,000 sq.ft. of floor space. No trouble is experienced with this heating system, even on the coldest day. The air supply is atmospheric, heated by passing it through a muffle in the kiln and then to the blower intake. A special small fan is used to mix fresh air with this heated air in the duct for office supply.

Installation of the kiln created an unforeseen problem: on one side of it valuable factory space was going to





waste, because workers found the heat unbearable. To solve this condition two overhead fans were installed on the opposite side of the kiln, with intake directly from windows, as shown in the illustration. Fresh air is thus blown across the top of the kiln, and down on the other side, making it possible to utilize otherwise unavailable space.

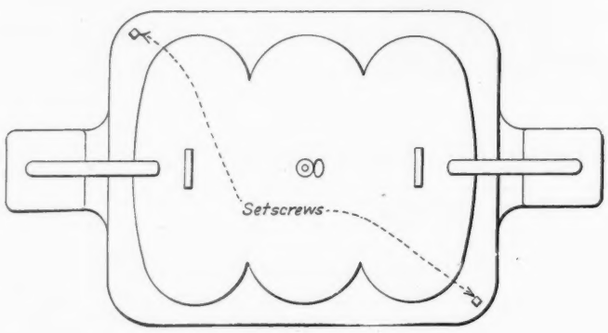
•

Setscrews Open Old Pump Casing

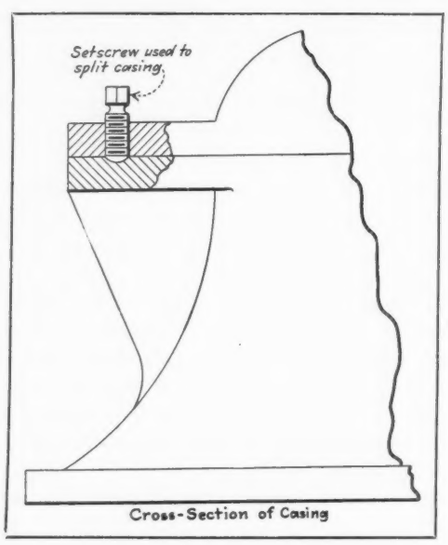
GRADY H. EMERSON, Birmingham, Ala.

It was necessary to split an old cold-water pump that had not been opened for several years. After much difficulty the holding bolts were removed. Then an attempt was made to drive a thin chisel between the halves. Next, several chisels were tried at the same time at different points around the joint. After several unsuccessful tries this procedure was abandoned because we were afraid of breaking the casing, gasket, or chisels.

Finally it was decided to send for an electric drill and two setscrews. The setscrews were $\frac{1}{2}$ in. in diameter and 2 in. long. Two holes were drilled diagonally opposite each other in the upper flange of the pump. The drill was marked to allow it to penetrate the lower half



only $\frac{1}{16}$ in. Then $\frac{1}{2}$-in. taps were used on the two holes. The setscrews were inserted in the tapped holes and wrenches were applied to both of them simultaneously. The result was that the upper casing was forced up evenly without damage to gasket, packing, studs, or casing. Although this example may be unusual the idea can be used widely.



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Tractor Driver "Don'ts"

GEORGE P. PEARCE, Moline, Ill.

In the interest of preventive maintenance, the department charged with responsibility for upkeep should see that drivers of industrial tractors are acquainted with these fifteen don'ts":

1. DON'T inch your controller
2. DON'T try to move your tractor unless you are on the seat
3. DON'T jam on your brake suddenly
4. DON'T leave your tractor standing with the power on
5. DON'T take a run to start a load

6. DON'T bump through swinging doors
7. DON'T throw your tractor from forward to reverse or vice versa until it has stopped moving
8. DON'T try to move a load by jerks that you cannot move by steady pulling
9. DON'T use your tractor as a battering ram in spotting trucks
10. DON'T sideswipe other objects
11. DON'T go over railroad crossings at full speed
12. DON'T run over obstacles in gangways—move them
13. DON'T run off the edge of gangways
14. DON'T fail to report any trouble with your tractor
15. DON'T wait, if anything goes wrong, until your tractor refuses to run before turning it in for repairs.

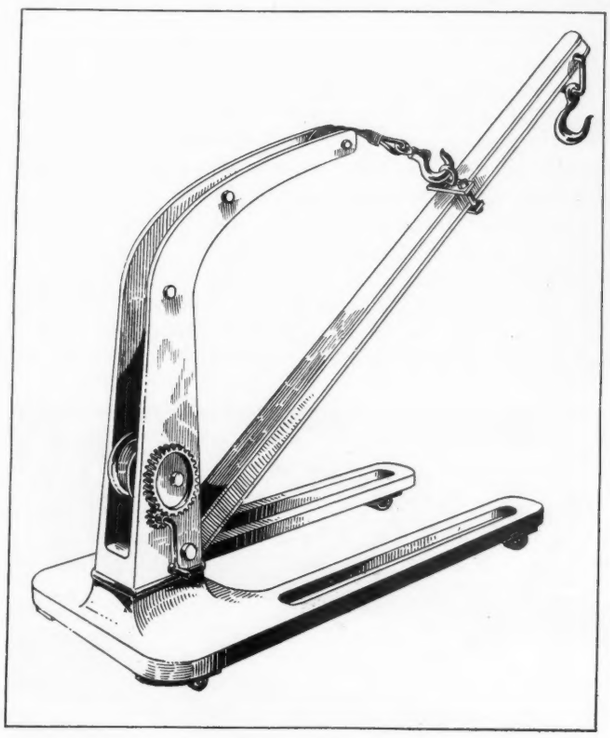
•

Extending Usefulness of Shop Floor Crane

CHAS. H. WILLEY, Superintendent of Manufacture
Hoyt Electrical Instrument Works, Penacook, N. H.

Often the shop floor crane cannot lift the object being handled quite high enough, for example when loading a truck. But, with a simple structural steel boom attached to it as shown in the sketch, it can handle such jobs easily.

For the average portable shop crane the installation is



mostly a matter of determining the proper size and length of boom and attaching it to the lower housing by a cross bar or shaft by means of suitable brackets or a hole in each leg of the frame.

Tiering Truck That's Lighter

SOURCE, The Elwell-Parker Electric Company, Cleveland

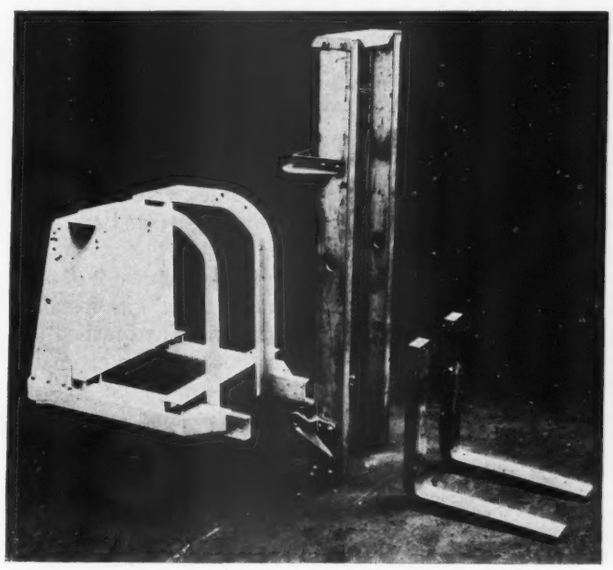
How exacting service requirements may be met by choosing the most suitable materials, is exemplified in a tiering truck recently built for a Chicago concern.

This company needed a truck that could handle a single unit weighing 1,800 lb. The difficulty lay in the fact that the floor load limit was 5,000 lb., and the combined weight of truck, motive power, batteries, and pay load exceeded this limit by nearly 500 lb.

To meet the conditions all the members shown in the photograph except two castings and the angle brace about two-thirds of the way up the upright channels, were made of aluminum alloy instead of steel. No strength was sacrificed; the saving in weight was about 550 lb.

Some slight change in design was necessary, but the operation of the truck was neither varied nor restricted. As a matter of fact, the truck would look like any other if it were not customary to have the forks unpainted. Only because they have been left bright is it possible to detect the use of the lighter material.

Of course the important thing was that the customer



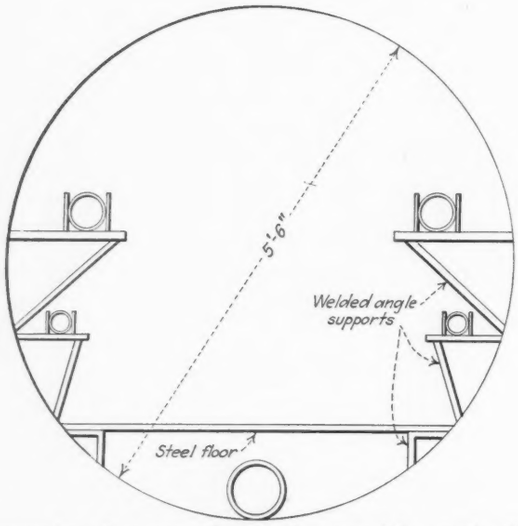
was able through this substitution of material and consequent saving in weight to use a piece of materials-handling equipment which he urgently needed in the conduct of his business.

•

Economical Service Tunnel for Steam and Water Lines

P. F. ROGERS, Brooklyn, N. Y.

An interesting service tunnel about 1,000 ft. in length recently was placed in service near Topeka, Kan., to take the place of the concrete construction usual for this service. This tunnel consists of a 66-in. diameter, corrugated sheet steel pipe laid in a trench excavated by a



Cross-section of corrugated steel pipe tunnel for service lines

dragline scraper operated from a small tractor crane. Within the pipe are welded angle structural steel pipe supports for an 8-in. steam line, a 4-in. return line, a 5-in. water line, and the necessary light and telephone conduits. A floor of $\frac{3}{16}$-in. steel plate is supported on angles welded on the side, high enough for the plates to clear the 5-in. water pipe on the bottom.

The tunnel pipe is in 20-ft. lengths with the supports for the pipe welded at 10-ft. intervals. This welding was done in the shops. The pipe is laid on a grade of between 2.75 and 0.45 per cent. Manholes are installed every 200 ft. that have four hinged sides which fold back when the cover is removed to give unobstructed entrance to the tunnel.

The necessary 3,000 cu.yd. of excavation cost less than 30 cents per cu.yd. The corrugated pipe was installed for about $12\frac{1}{2}$ cents per foot for labor. The finished job is said to have saved about $2 a foot over the estimates for a concrete tunnel of the same size. Pipe sections were joined together by 12-in. corrugated galvanized bands, which fitted over the corrugations of the ends of the pipe and were drawn tight by lug bolts.

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Painters at United Parcel Service, New York, brighten the corners where they are with light from an adjustable lamp and reflector mounted on a convenient four-wheeled painting kit.

•

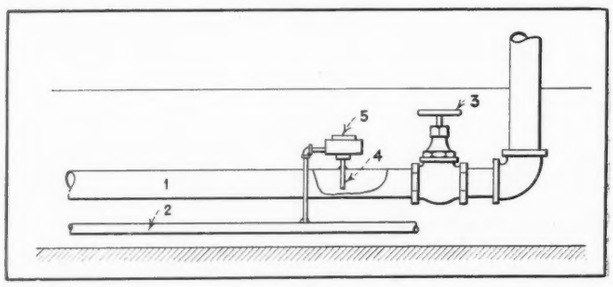
Unusual Trap Installation Effectively Removes Condensate

C. C. HERMANN, Waterloo, Iowa

A steam main became water-bound due to closing the heat to an adjacent building. The condition is illustrated. Valve, 3, in the steam main, 1, was closed; water hammer resulted. A trap was not installed at the bottom of the main, in the ordinary way, because the main was in a floor trench, making that procedure expensive.

Here is what was done: A hole was cut in the top of the main with a torch and a short piece of pipe, 4, was inserted into the main to within $\frac{1}{2}$ in. of the bottom. This pipe was welded to the main and the steam trap, 5, was secured to the top end. The trap was piped to the return line, 2, in the regular manner, after welding a nipple in the return line near where the trap was installed.

The actual time consumed for the complete job was $2\frac{1}{2}$ hours, including the time for cutting and welding. The pipe and fittings used were: 8 in. of 1-in. pipe; 2 ft. of $\frac{3}{4}$-in. pipe; a $\frac{3}{4}$-in. ell; a $\frac{3}{4}$-in. nipple; a 1-in. steam trap.



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Four photoelectric units, one for each web, watch for paper breaks, operate relays that shut down the *New Britain Herald's* press, prevent damage and delay.

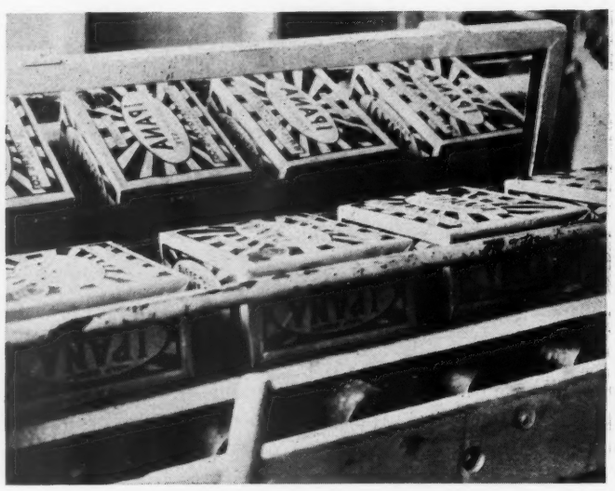
•

Done With Mirror

SOURCE, Bristol-Myers Company, Hillside, N. J.

It's the side you don't see that counts during packaging inspection. And to make sure that cartons are properly wrapped and sealed at both ends, a mirror has been installed on the belt conveyor that carries packages of Ipana toothpaste to the packers.

The mirror helps a lot. The operator can sort of look into it out of the corner of her eye and see if all is well on the offside of the moving line of packages. She can see much better than would appear from the photograph, can detect at once any irregularity. If a package offends, she plucks it out.



· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

•

What Are Employees' Obligations Under the NIRA?

In the corner drug store. George Shipman, a works manager, has just bought and lit a cigar. As he turns to go out he sees his friend Frank Fulleger, a plant engineer, and another man seated at a table having sandwiches and coffee. Greetings over, Shipman accepts Frank's invitation to sit with them while they finish their lunch. The third man is introduced as John Cadwallader, chief inspector at Frank's plant, and Fulleger refers to their discussion for Shipman's benefit.

* * *

"John has just been telling me about the remarks of some of our employees, George. About hours and wages under the Recovery Act, you know; everybody's talking it now."

"All happy, I suppose, Mr. Cadwallader?" Shipman asks.

"Well, yes and no, Mr. Shipman. As I was just telling Frank, I haven't heard anybody object to getting more money or working fewer hours. And I heard lots of plans for auto trips, and baseball, and tennis, and other things. Fact is, most of the people I overheard seemed to take it for granted that everything was as it should be —fewer hours for all, more money for some, not much less for others. They all seemed to feel that they were getting something additional.

"But what surprised me was that three or four wondered where the money is coming from. How could the company do it? Referred, in fact, to the last financial statement, which showed a loss, and——"

Frank interrupts. "Excuse me, John; didn't they realize that prices are going up? That we're going to get more for what we make and sell?"

"I gather that they did," John replies, "but they seemed to discount that a whole lot, because they know it takes time to put prices up. Wondered what the firm is going to do in the meantime."

Shipman enters the conversation again. "That's mighty interesting, Mr. Cadwallader, but seems to me it's a bit too big a topic for them to handle. So far as I know, our well-known economists haven't settled that one yet. What would interest me is anything they had to say about what *they* can do to help the firm. Did they happen to say anything about whether or not the employees have any added responsibility toward the firm? Are they working at top-notch efficiency now? Are they doing just a day's work, so to speak, or are they pressing some, with the idea of keeping costs down? In other words, do they feel that it's a case of one-for-all, all-for-one? See what I mean?"

"I think I do, Mr. Shipman. And I'm just as much interested as you are—and so is Frank. But I didn't get any reaction on those points. The remarks I've heard leave me with the impression that there are just two kinds of employees. One kind is tickled because things are coming their way, the other kind wonders how it can be done."

"And that seems to be that," says Fulleger. "Also we've reached the end of the sandwiches, and I for one am afraid to take any more coffee at night. Shall we go? Ride you home, George."

"No, thanks, Frank; my car's outside. I've enjoyed talking with you, Mr. Cadwallader. Goodnight. Goodnight, Frank."

* * *

It's a safe bet that these three men will get together again to talk over the same subject. But, in the meantime, things move rapidly. Let's don't wait for their conclusions, if any.

Does the employee have added obligations toward his firm under the National Industrial Recovery Act? What are they? How can he meet them?

•

Discussion of previous questions begins on the following page.

ANSWERS TO PREVIOUS QUESTIONS

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What of Cost-Cutting Equipment Under the NIRA?

(Question presented in the September issue)

WITH THE advent of industrial codes, this is one of the most serious problems affecting the decorum of industrial engineers. Engineering societies must adjust their codes of ethics to conform with the new principles involved.

The new industrial codes must be analyzed and weighed in the balance, in the light of their intended purposes, and too much emphasis must not be placed upon what they may seem to imply. The codes are being formulated for the advancement of business and the progress of industry toward greater achievements than we have ever experienced in the past. In some of the basic purposes we have precedents which have not wrecked foreign or American business in the past, when they have been used with discretion. Unfortunately the American people do not heed the handwritings on the wall, and this failure is to be feared more than all the codes themselves, no matter how insanely they may be formulated.

All of the codes have three fundamental objectives: (1) control of production, (2) insurance of fair treatment of labor, and (3) elimination of unfair business practices and wasteful competition. When we consider machines under the NIRA we must analyze them in the light of these three basic principles.

Roughly we can classify machines into three main groups: (1) those which perform functions of which man is not capable, (2) those which relieve man of fatiguing work, and (3) those which combine or reduce operations, consequently reducing the number of operators.

Obviously the NIRA does not attempt in any way to curb the creation or perfection of machines which perform tasks that are unthinkable for man. Man cannot, by his own hand, turn energy into electricity, and if we were to infer from the codes that electrical apparatus was to rest on its laurels, with nothing new invented or developed, it would be nothing more than industrial suicide. Further, we must not forget that thousands are employed, either directly or indirectly, in such industries. If we declared a moratorium on their products, these same thousands would be unemployed, thereby going counter to the purpose of the NIRA.

President Roosevelt has steadfastly maintained that the conditions of the American workman must be improved. Any machine tool which tends to alleviate physical exertion will not meet opposition from labor.

In discussing the last group, those machines which combine or reduce operations, we find the greatest difference of opinion. In order to determine our position we must weigh two facts very carefully. If we check up our present equipment, we shall find, generally, that we are not obtaining more than 25 per cent of its use in the total time it is operating. Therefore any equipment we might purchase, that would combine two operations, would only reduce the cost about 15 per cent. We need more attention paid to waste motions and to increase the "DO" time. This was imperative whether we evolved codes or not.

Industrial engineers have a great piece of missionary work to perform with management. Today we have too much idle plant and equipment, except for peak production. The sad part is, we must pay interest, depreciation, and taxes on all of it. During the past depression, generally, economies made on labor amounted to less than the fixed charges in a plant. If the industrial engineer can advise management properly, in the future, against such marginal return equipment, they will have benefited the workman and the consumer both. It all means that only in a very few cases will automatic machines be fully justified, and this is no change from conditions prior to this year.

The codes are eliminating that wasteful nefarious cutthroat competition that we all have been ranting about, and it is placing all like industry on an equal basis. From now on it is a case of the best brains coming out the winner, and there is no doubt that some new equipment will be necessary to augment management's endeavors. The "lowest price with the highest quality" will continue to reign as in the past. Certain cost-reducing equipment will be necessary, and the machine tool manufacturers needn't fear going out of business. However, more sound economics must be displayed than we have shown in the past.

If we continue along, without becoming too excited about what the "New Deal" MIGHT do, and just use our best judgment, we shall have nothing to fear, and shall all enjoy unprecedented success.

D. M. HEIDER, *Standards Division*
Du Pont Viscoloid Company
Arlington, N. J.

PRIMARILY, the code is to aid distribution, particularly among the lowest income brackets. The only reason production is controlled, in some industries, is because cutthroat competition springs up, as a result of which wages are cut to meet competitors' prices. To assure labor of a livable income and prevent the unscrupulous manufacturers from getting the advantage of those who are willing to pay decent wages, some restraint was necessary. That is the only justification for limitation of output.

From good times to bad, the national income only dropped about 25 per cent. If every individual's income in the country had been cut 25 per cent, there would have been comparatively little hardship. The trouble was in the distribution, because a good many lost all their income, others comparatively little. Those who lost most were those who could afford it least, and those are the people the NIRA is intended to help by better distribution. That is why the government is making no effort to help those earning over $35 a week. It is felt that they can live on that without aid from the government.

Suppose average wages were doubled, from $10 to $20. What good would it do if prices went up three times? And prices would go up even more than three times if we restricted the use of cost-cutting equipment.

Approximately 100 man hours are now required to build an auto, against 1,500 hours a few years ago. At 60c. an hour the labor cost is now $60 per car against $900. Of course, it seems as if employment would go up 1,400 per cent. But, instead of one car for five people in the country, there would only be one in a hundred at the most who could afford it. Instead of twenty cars sold for 100 people at 100 man hours each, we would make one car at 1,500 man hours. The man hours would go down from 2,000 to 1,500, or a reduction in work of 25 per cent, and autos would be put out of the reach of most of the people. Foreign cars would be cheaper than domestic.

And what of the supplementary industries? Gasoline sales would be 1/20 of present sales, equipment manufacturers would close up, railroads would lose thousands of tons of freight, every supplier of crude material, mines, farms, lumber yards, chemical plants, would lose their largest customer, the auto industry.

Poor Mr. John Public wouldn't gain much by clamping down on cost-cutting equipment, would he?

BERNARD SHEREFF
Engineer, Standards Department
American Hard Rubber Company
Butler, N. J.

To Buy or Make Replacement Parts?

(Question presented in the July issue)

GENUINE renewal parts, made by the original equipment manufacturer, are the most economical and will eliminate the cheap makeshift maintenance and national waste which is being practised by a great many maintenance supervisors throughout the country. The sooner we, as an industrial nation, bring about good standard practice on maintenance, then, and then only, will the maximum economies be realized.

The original equipment manufacturer who cares about his product cares more about its maintenance and renewal parts and the service it is giving to his customers than anyone else. The user of any equipment who permits the original equipment manufacturer to forego this responsibility, by using homemade or other inefficient renewal parts, is not practising economy and is not placing the responsibility for the service and maintenance of his equipment where it belongs.

Anything that operates will wear, and where this wear occurs renewal parts should be available for immediate installation and a minimum stock carried for insurance of continuous operation. When a company builds a factory it takes out insurance against fire, but when it comes to investing in the insurance of continuous operation and having a suitable renewal parts stock, for parts which it knows are wearing, and which it knows must be replaced for continuous operation, this type of insurance money does not seem to be available.

You cannot buy good and cheap renewal parts any more than you can buy anything else both good and cheap. Therefore it is an extravagance to pay more and a gamble to pay less.

E. C. BRANDT
Manager, Renewal Parts
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

IF THE part in question is for a current machine and wears out periodically, in regular operation, then the obvious answer is to purchase and have on hand a supply of these parts in anticipation of replacements. In general, regardless of the plant equipment or efficiency, it is cheaper to buy replacement parts from the original supplier than to make them, because the supplier makes them in quantity with tools provided for that purpose.

If, however, the part is for an obsolete model and the supplier has discontinued carrying it and has scrapped the tools used for making it, then he will have very little cost advantage over the plant needing the part. In this case, it would probably be advisable to make the part.

In either case, mechanical judgment and common sense will have to decide the question.

GEORGE ALLISON
Assistant Works Manager
Mergenthaler Linotype Company
Brooklyn, N. Y.

More or Fewer Records?

(Question presented in the August issue)

PRODUCTION records in the broadest sense are used to reduce manufacturing costs and assure prompt deliveries. In no case can they rightfully be expected to do more than this. Properly designed, they give first hand information on all essential facts pertaining to manufacturing. Accurately compiled they serve to eliminate waste, and push ahead in the direction of greater profits. And, by being kept alive, adequate records will protect the plant executive against loss, failure, or unwise procedure.

Obviously, then, the objective in keeping production records is not exactly "More or Fewer Records," but rather in keeping adequate records. Records of this type will not only show management the how and why of production schedules, but can be made to show the causes that are back of each condition. They can be used to stimulate interest and to arouse competitive ambition.

There are many methods and devices available for record-keeping purposes, such as charts, diagrams, curves, bookkeeping machines, tabulating machines, and others, and the alert executive in selecting the one best suited to his particular needs will no doubt do so with a degree of simplicity commensurate with the results wanted.

HERBERT D. HALL, *Manufacturing Engineer*
Westinghouse Electric & Manufacturing Company
Sharon, Pa.

PLANT organizations may be mainly classified as follows: (1) Those relying on mass records to disclose all perfections or imperfections; (2) Those believing that, as long as a factory is making money, conditions

(Continued on advertising page 39)

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Synchronous Motor Field Arcs to Ground

I am having trouble with the field arcing to ground on a synchronous motor rated 500 hp., 5,000 volts 52 amp., three-phase, 60-cycle, 600 r.p.m. Excitation current at full load is 42.8 amp. Discharge resistor is rated 45 ohms, 22 amp., 600 volts. This motor has always given trouble. It starts under full load, driving pebble mills, and the field current jumps to ground near the squirrel-cage winding, about ½ in. away, about the instant that the compensator is thrown from the start to the running side. The field is applied by a knife switch. I have tested for grounds but found none. Resistance is not open. All connections from terminals have been checked. Heavier endrings were placed on the squirrel-cage winding since the original rings became so hot on starting that eventually they cracked. Would decreasing the discharge resistance tend to reduce the arcing? If so, how much could the resistance be reduced? I should like to know whether anyone else has had this trouble, and what he did to remedy it.

H. C.—Saginaw, Mich.

IN VIEW of the fact that the arc takes place when changing from the starting to the running position of the compensator, I suggest that the field be excited before shifting to the running position.

I have had considerable experience with synchronous motors, and as a result I favor a very low discharge resistance.

Of course, the field circuit should be carefully examined for loose connections and poor contacts.

C. E. ROGERS
East Angus, Que., Canada.

NUMEROUS causes of synchronous motor fields arcing to ground have come to my attention. The chief cause is dust accumulating between the coils and around the ring insulators.

If the operator throws the compensator to the running position too quickly a severe strain will be put on the insulation, because a high-voltage induced current is thrown into the field circuit where the voltage is naturally high, anyway. If this induced current were not present, it would not be necessary to install a resistor across the field circuit.

It is possible that the endrings are not heavy enough for the starting duty, or the motor may be required to start more frequently than designed for. If this is the case the manufacturer will probably be able to give advice as to the most suitable type of endrings.

It may be possible to eliminate the trouble by reducing the starting load on this motor, putting on the full load after the machine has reached synchronism. This could be done with a mechanical or a magnetic clutch, preferably the latter.

A possible cause of the trouble may be that the compensator taps are set too low so that the machine does not reach a high enough speed to enable it to pull in without a jerk. I would advise checking the voltage of the line when the motor is being started. If the voltage varies more than 15 or 20 per cent it might be advisable to put in a larger line.

If the machine has an individual exciter driven by it the field switch may be left in at all times. Doing this will tend to keep the induced voltage down.

(Continued on advertising page 36)

ANSWERS WANTED

Checking Motor Loads by Kilowatt-Hour Meter

I want to check up the loads on some of our circuits and motors, but am hampered by the lack of instruments. It is possible, so I have been told, to do this by means of the kilowatt-hour meter on the switchboard. Will someone please tell me just how to do it? *T.M.K.—Nashville, Tenn.*

Should Production Direct Maintenance?

Our production department claims that if it were given authority to tell the maintenance department "what to do" output could be increased and costs lowered. We would like to secure these results, but are not sure that this is the way to do it. At present neither department has any executive authority over the other. I should like to know what the experience of other plants has been in the matter of giving the production department authority over maintenance. *P.J.Q.—Chicago, Ill.*

Handling Motors Mounted Overhead

Occasionally it is necessary to change lineshaft motors mounted overhead, either to meet changes in production volume or because of trouble. We find that this is a rather troublesome job, possibly because we may not be handling it in the best way. Our motors range from 5- to 50-hp. rating, and are mounted at heights varying from 10 to 15 ft. I wish that other readers would describe the best methods they have found for taking down and putting up motors of the sizes indicated. *B.H.H.—Atlanta, Ga.*

· EQUIPMENT NEWS ·

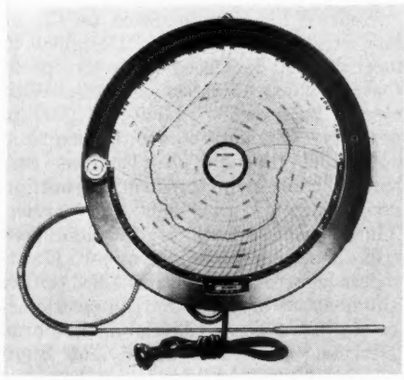
Trucks

Yale & Towne Mfg. Co., 405 Lexington Ave., New York, announces purchase of real estate, machinery, tools, inventory, patents, and goodwill of Walker Vehicle Co. and Automatic Transportation Co., Chicago, makers of industrial electric trucks. Will continue manufacture and sale of complete line of each company at 101 W. 87th St., Chicago.

Compressor

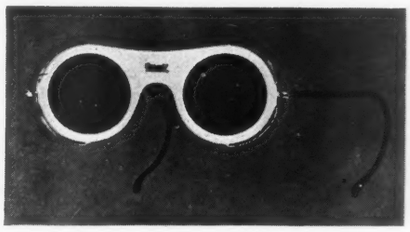
Single-stage, belt-driven, for heavy-duty service. Class ES. Has one horizontal, double-acting cylinder. Operates at moderate speeds. Available in sizes from 10 to 125 hp., and for discharge pressures from 5 to 150 lb. Designed for full-load, continuous service, and for economical standby service for large compressors whose full capacity is not always needed. Will handle poisonous or flammable gases. Ingersoll-Rand Co., 11 Broadway, New York.

Gages



Indicating and recording. Eight- and 12-in. circular-chart instruments in 1-, 2-, or 3-pen models. Thermometers for indicating and recording temperatures from –40 deg. F. to 1,200 deg. F. Pressure and vacuum gages for ranges from 10 in. of water to 5,000 lb. Thermometer has mercury-filled helix of stainless steel. Gas- and vapor-type helices are heat-treated phosphor bronze. Thermometers may be located at distances up to 200 ft. Pressure and vacuum gages have three types of actuating movements: for low pressures, flexible metal diaphragms; for medium ranges, spring-opposed bellows; for high ranges, helices. Electric clock is standard for all models. Where a.c. current is not available, hand-wound clocks are furnished. The Brown Instrument Co., Philadelphia, Pa.

Spectacles



Oxweld No. 15, with type AA lens, for oxy-acetylene welding and cutting. Lenses, 50 mm. in diameter, mounted in natural canvas-bakelite frame. Temples covered with insulating material. Frame is non-flammable, does not conduct heat. Provision for quick change of lenses. Type AA lens, flat-ground and polished, is made in light, medium, and dark green shades, conforms to all code requirements including those of Federal Government. The Linde Air Products Co., 30 E. 42nd St., New York.

Boiler

Oil-burning, in sizes from 5 to 500 boiler horsepower and working pressures from vacuum to 200 lb. "Oilbilt" has boiler and burner as integral unit. Air delivered to combustion chamber by blower. Automatic controls for intermittent operation to fit demand. No stack draft required. Eighty per cent efficiency claimed by manufacturer. Boilers can be used for heating building as well as for power by installation of pressure-reducing valves. Cleaver-Brooks Co., Milwaukee, Wis.

Tank

Pressure. Feed, for spray-painting. Sixty-gallon capacity. Height 39¼ in., width 24 in. Walls of 0.125 open-hearth steel, galvanized inside and out. Pressed-steel, cadmium-plated cover has 12 clamps. Revolving agitator. Pressure regulator and gage, safety valve, relief valve, air-inlet valve, two air and two fluid outlets are standard equipment. Supplied with top or bottom outlet, with or without gage-glass material-level indicator. The DeVilbiss Co., Toledo, Ohio.

Steam-Generating Equipment

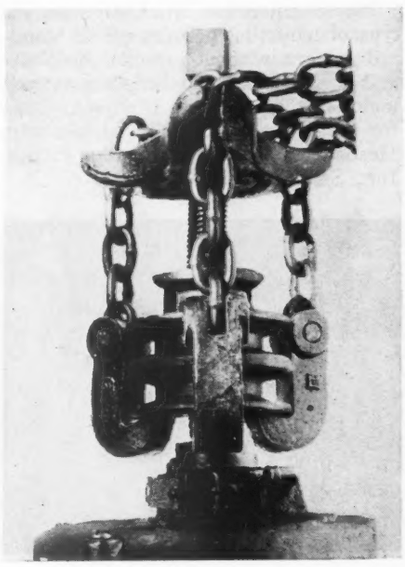
Combustion Engineering Co., Inc., a newly organized company, has taken over properties of International Combustion Engineering Corp. and affiliated companies recently sold by order of Federal Court. New company will continue old companies' complete lines of fuel-burning, steam-generating, and related equipment.

Relay

Photoelectric, Type FSE. Incorporates "Visitron F2" cell, sensitive relay, and auxiliary electromagnetic relay housed in small cast-aluminum case 6½x5⅞x4 in. Cell can be mounted behind glass window in front of case or externally at any point within 100 ft. of sensitive relay. Unit can be weatherproofed. Visitron F2 cell requires no external voltage and no amplification. Unit can therefore be used in locations not served by electric power lines. Parts of unit may be purchased separately. G-M Laboratories, Inc., 1735 Belmont Ave., Chicago.

Puller

"Steelgrip," universal. For pulling wheels, pulleys, gears, bushings, and pinions. Consists of bracket with pulling screw and three chains. Will handle work at any distance from end of shaft. Chains are double-ended, have standard chain hooks for gripping spoked wheels or large gears on one end and special hooks to take close grip for bushings,



small gears, motor pulleys, or in close quarters. Two sizes: pulling capacities of 12,000 or 36,000 lb. Armstrong-Bray & Co., 308 Sheldon St., Chicago.

Knife Grinder

Automatic, with electric time control. Type "M" is designed for sharpening machine knives and light shear blades. Will give flat or concave bevels, grind wet or dry, away from or toward cutting edge. Grinding operation, including cross feeding and table traverse, automatically controlled by electric timing device which cuts off power and stops machine at any elapsed time from 1 to 45 min. Rotation of grinding wheel reverses at end of each table traverse. Motor is ball-bearing, 60-cycle, with oil-immersed reversing and magnetic switches. Four sizes: 38-in., 55-in., 76-in., and 90-in. Samuel C. Rogers & Co., 191 Dutton Ave., Buffalo, N. Y.

Pipe Cutter

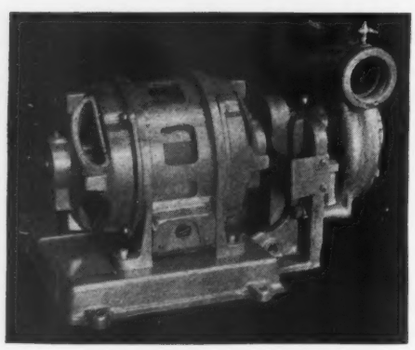
Beaver No. 100, for thin-walled tubing. Sizes $\frac{1}{8}$ to $\frac{3}{4}$ in. Also Beaver No. 204 Square-built Wheel Cutter. Similar to No. 102 in construction principle. Sizes $2\frac{1}{2}$ to 4 in. The Borden Co., Warren, Ohio.

Motors

Cedarburg Manufacturing Co., Cedarburg, Wis., has acquired property and patents of American Electric Motor Co., formerly subsidiary of Splitdorf-Bethlehem Electrical Co., Newark, N. J. Will continue manufacture of American Electric motors in sizes from $\frac{1}{2}$ to 30 horsepower.

Pump

Motor-centrifugal. Close-coupled type of mounting permits use of standard motors without special bedplates and brackets. Pump bedplate extends under motor. In sizes from $\frac{3}{4}$ to 4 in., for capacities up to 1,000 gal. per min. Heads from 10 to 290 ft. Goulds Pumps, Inc., Seneca Falls, N. Y.



Lubricant

"Bestolife." Protective element is metallic lead, finely divided, and suspended in lubricant vehicle. Said by manufacturer to form thin protective film of lead on all contacting surfaces, forming anti-frictional areas. Minimum constituency of lead 15 per cent, maximum 65 per cent. Claimed to withstand temperatures up to 430 deg. and not to lose all lubricating stability until melting point of lead is reached at 590 deg. Principal applications in industrial field are as pipe-joint compound, for service cocks, wire lines, and slow-speed gears. Armite Laboratories, 1450 E. 61st St., Los Angeles.

Trap

No. 500, steam, inverted-bucket type. For handling a considerable volume of condensate. Self-venting. Motive element is inverted seamless open bucket operating through cast brass lever arm to open and close swivel valve pin. Trap discharges intermittently. Suitable for working pressures up to 125 lb. per sq.in. In three sizes: $\frac{1}{2}$, $\frac{3}{4}$, and 1 in. Jas. P. Marsh Corp., 2073 Southport Ave., Chicago.

Welder

"Protected-Arc." Welding range of 40 to 550 amp. Dual adjustment. Generator has four main poles, four interpoles. Ball bearings throughout entire machine. Motor is standard induction line-start type. Motor starter magnetic, push-button operated. Exciter mounted directly on main generator shaft. Rating 40 volts. Open-circuit voltage, 25 to 80 volts. Entire machine inclosed and mounted on welded-steel truck. Length 52 in., height 36 in., width 24 in. Weight 1,400 lb. USL Battery Corp., Niagara Falls, N. Y.

Push Buttons

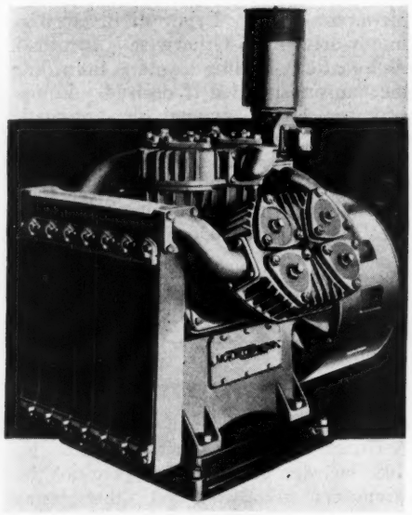
Start-Stop. Buttons 1 in. in diameter. Buttons and stems are one piece, molded bakelite. Contacts silver-to-silver, double-break. Mechanism mounted in porcelain base, removable as unit. Mounting dimensions, $2\frac{1}{2}$ in. wide, $4\frac{1}{4}$ in. high, $2\frac{7}{8}$ in. deep. Designated as Class 9001, type B20. Also built with dust-tight and water-tight inclosure. Square D Co., 710 S. Third St., Milwaukee, Wis.

Carrier

Type WTH, for operation on Cleveland tramrail systems. Designed to meet demand for speed from "creep" to that at which operator can walk. With electric hoist of 500-, 1,000-, or 2,000-lb. capacity. Standard control by magnetic contactors through push buttons suspended from swinging arm, permitting control from either end of carrier. Time-limit automatic-acceleration control furnished for travel motor. Hoist-motor control can be furnished either single-speed or time-limit automatic-accelerating type. Cleveland Tramrail Division, Cleveland Crane and Engineering Co., Wickliffe, Ohio.

Indicator and Recorder

For density of smoke passing through stacks or breechings of power and heating plants. Photoelectric. Essential elements of apparatus are light source and photoelectric relay unit. Recording instrument optional. Unit and light source designed for mounting on opposite sides of stack with smoke passing between. Adjustable electrical contact for operating alarm circuit is provided and can be adjusted to any point between 20 to 60 per cent of full smoke density. General Electric Co., Schenectady, N. Y.



Compressor

Air. Air-cooled. Called "Motor-compressor." Built-in motor. Motor rotor carried on compressor shaft and motor frame bolted directly to compressor crankcase. Two-cylinder, 2-stage machine. Cylinders and intercooler air cooled. Sizes from 20 to 50 hp., with piston displacements from 113 to 310 cu.ft. per min., discharge pressures up to 125 lb. gage. Ingersoll-Rand Co., 11 Broadway, New York.

Switch

Type "D." For use on all types of Cleveland tramrail hand-propelled carriers and for certain types of electrically operated carriers. Permits close switch grouping and rail spacing. Members are rolled steel welded together. Rigid outer frame has sliding inner member for maintaining proper alignment of switch and incoming rails. Can be electrified by addition of conductors and conductor-bar supports. Also Type "E," for extremely close grouping and rail spacing, and for hand-propelled carriers only, loads not to exceed one ton. Cannot be electrified. Cleveland Tramrail Division, Cleveland Crane and Engineering Co., Wickliffe, Ohio.

Pump

Centrifugal, for handling corrosive chemicals. Model 2A. Has 1-in. suction, 1-in. discharge, and at 1,750 r.p.m. capacity ranges from 2½ gal. per min. at 25-ft. head to 25 gal. per min. at 5-ft. head, with power consumption varying from ¼ hp. to less than ½ hp. for water. Available in belt or direct-motor drive. Has closed-type impeller. Procurable in Duriron for general acid service, Durichlor for hydrochloric acid, Durimet (low-carbon nickel-chromium-silicon alloy steel) for weak sulphuric acid, Durco Alloy Steels (low-carbon "18-8"), Alcumite (copper-aluminum-iron alloy) for weak sulphuric acid, and in chemical lead alloys. The Duriron Co., Inc., Dayton, Ohio.

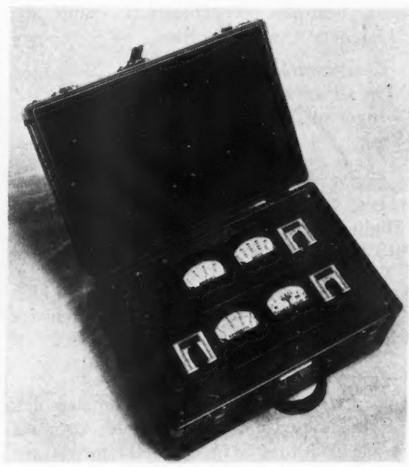
Screens, Conveyors, Dryers

Patent, manufacturing, and selling rights for products of the Traylor Vibrator Co., Denver, Col., have been acquired by The Jeffrey Mfg. Co., Columbus, Ohio, which will continue manufacture and sale of Traylor lines through Jeffrey-Traylor Division of The Jeffrey Mfg. Co. at Columbus.

Motor Starter

No. 1 Type ZOS, Oil-immersed, Across-the-line, Combination Magnetic. For motors up to 15 hp., 220 volts, and 30 hp., 440-550 volts. Contains unfused or fusible safety switch, magnetic starter with overload relays, and heavy-duty test jacks for applications where it is desired to insert meters in motor circuit without interrupting operation of machine. All internal wiring of starters is complete. Safety switch is front-operated. Cover swings vertically. The Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland.

Test Set



Portable, A.C., known as "Industrial Analyzer." Suitable for making complete tests of industrial apparatus and motors up to 125 amp., 500 volts a.c. In 7x11x19-in. carrying case complete with all necessary switching equipment, transformers, and resistors. Contains triple-scale ammeter 0-5, 0-25, and 0-125 amp., polyphase wattmeter with three scales for above voltage and current ranges, and polyphase power factor meter with 10-100-80 scale. Instrument scales 3½ in. long. Westinghouse Electrical & Mfg. Co., East Pittsburgh, Pa.

Draft Regulator

Type HF-1, hydraulic. For boilers up to 200 hp. Identical in fundamental design with Type HF-2. Can also be used to control fan speed, or ventilating-system pressures or drafts. Operates on beam-scale principle. Bell, suspended from beam, immersed in oil seal, measures draft. No diaphragm. Carrick Engineering Co., Box 299, Michigan City, Ind.

Motors

Synchronous, small- and medium-capacity. Starting and pull-out torques claimed to be practically same as squirrel-cage motors. Self-synchronizing and separately excited. Give leading power factor of 0.9 on full load. Poles fitted with amortisseur windings. Sizes from ½ hp. at 1,800 r.p.m. to 40 hp. at 900 r.p.m. Columbia Electric Mfg. Co., 1292 E. 53d St., Cleveland, Ohio.

Lubricants

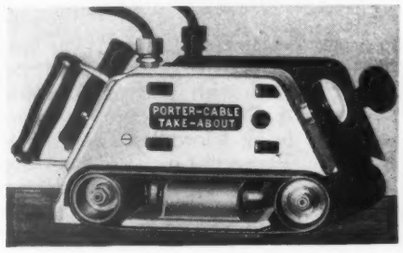
Known as "Sta-Put." Made from mineral oil polymerized under controlled heat and pressure. Treatment said to result in complete re-arrangement of molecules of oil without change in chemical content, producing closer bond between all molecules and increase in film strength. Made in three series and available in grades for variety of industrial uses. The 300 series are liquid; 400 series made especially for gear lubrication; 500 series are greases for screw-down grease cups and automatic grease lubrication systems. E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa.

Union

High-pressure. For steam, oil, gas, water, and air lines. Has two serrated ends, one hard and the other soft, forming four seats. Can be used several times. Black or cadmium-plated. United Superior Union Co., 29 Ryerson St., Brooklyn, N. Y.

Sanding Machine

Hand, belt. Type T-3 "Take-About." For sanding, grinding, and polishing. Weight 15 lb. Uses standard 3x24-in.



abrasive belt. No adjusting nuts or adjusting screws. Right side of machine free from obstruction to enable sanding right up to uprights. One-half-horsepower universal motor operates from light socket on either a.c. or d.c. current. Bench stand can be furnished. With it idler pulley can be used as spindle sander for curves. Felt and canvas belts can be supplied for polishing and rubbing. The Porter-Cable Machine Co., Syracuse, N. Y.

Gages

Compact, electric contact. For draft, pressure, and differential draft or pressure in ranges between $\frac{1}{10}$-in. water and 100 in. water. High- or low-contact service or both. Equipped with closed mercury switches or open contacts. Cast-aluminum case can accommodate one or two single- or double-contact units or a single- or double-contact unit and a second unit which indicates on 3-in. scale pressure or draft being measured. Suitable for sounding alarm or lighting bulls-eye when pressure reaches predetermined point. With intermediate devices, for opening and closing dampers, starting and stopping fan motors. The Hays Corp., Michigan City, Ind.

Oiler

For loose pulleys. Called "Vosta." Consists of glass body and bronze base in which tube is mounted, extending to near top of bottle. As pulley revolves, oil is thrown outward by centrifugal force. Feeding governed by thermal principle. The Lunkenheimer Co., Cincinnati.

Fan and Heater

Portable, motor-driven, combination. Known as "Chromalox Electric Heetflo." Equipped with switch which operates either fan or heater; fan in summer, heater in winter. Shaded-pole-type motor. Oilless bearings. "Chromalox" inclosed-type 1,000-watt heating element. Nine inches high, 8½ in. wide. Art-style bronze finish. Edwin L. Wiegand Co., 7518 Thomas Blvd., Pittsburgh, Pa.

Finishing Materials

Western business of The Zapon Co., subsidiary of Atlas Powder Co., has been combined with that of Brevolite Lacquer Co., North Chicago, the consolidation being known as The Zapon-Brevolite Lacquer Co. Products are lacquers and pyroxylin-base finishing materials, and company headquarters are at North Chicago.

Finishing Machines

Types YBA and YBB Rotary Spray. For finishing small and medium-sized articles. Capable of approximate hourly production of 1,000 — 3,000 small, light articles, such as bulbs, bottles, jars, auto parts. Suitable for intermittent or limited production. Type YBA is air-motor-driven, Type YBB electric-motor-driven. Otherwise identical. Automatic loading and unloading mechanism supplied if desired. Equipped for either manual or automatic spray-gun operation. Standard 24-in. turntable, may be equipped with 30-, 36-, or 42-in. tables. Spindle standard is 24, but 18 to 48 may be used. The DeVilbiss Co., Toledo, Ohio.

TRADE LITERATURE

CHAINS AND SPROCKETS—Catalog 583, 96 pages, "Diamond Chains and Sprockets," includes information on where and how to use Diamond products.—Diamond Chain & Mfg. Co., Indianapolis, Ind.

CLAMP—List No. 103, "The Bull Dog Pipe Welding Clamp"—Oster-Williams, 2057 E. 61 Place, Cleveland.

CLEANER—Folder, "Improved Solvent Cleaning for Metals."—Rex Products & Mfg. Co., 13005 Hillview Ave., Detroit.

COMMUTATORS AND SLIP-RINGS—Bulletin, describes company's manufacturing and repair service.—Columbia Electric Mfg. Co., 1292 E. 53d St., Cleveland.

COMPRESSORS—Bulletin W-850-B32, portable air compressor with 120 cu.ft. per min. capacity; Bulletin W-850-B33, 240 cu.ft. per min.; Bulletin W-850-B34, 310 cu.ft. per min.; Bulletin W-850-B37, 360 cu.ft. per min.—Worthington Pump and Machinery Corp., Harrison, N. J.

COMPRESSORS—Form 3063, 20 pages, "The Class 'ES' Heavy Duty Compressor."—Ingersoll-Rand Co., 11 Broadway, New York.

CONVEYOR—Data Book No. 1289, 128 pages, "Caldwell Helicoid and Sectional-Flight Screw Conveyor."—Link-Belt Co., 910 S. Michigan Ave., Chicago.

CONVEYOR CHAINS—Folder No. 1365, "Link-Belt Conveyor Chains for Glassware, Bottles, Jars, Cans."—Link-Belt Co., 910 S. Michigan Ave., Chicago.

COUPLING—Bulletin V-110, complete data on Whitney roller chain flexible coupling.—The Whitney Mfg. Co., Hartford, Conn.

CRUSHER—Bulletin 1469-C, 16 pages, "Style 'B' Newhouse Crusher."—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

DRAW BRIDGES—Bulletin, 2 pages, "Kinnear Draw Bridges Solve Cross-Over Problems."—The Kinnear Mfg. Co., Columbus, Ohio.

FLOOR—Booklet, 22 pages, "Belmont Rolled Structural Steel Interlocking Channel Floor."—Belmont Iron Works. 22d St. and Washington Ave., Philadelphia.

GAGES, VALVES, ETC.—General Catalog, loose-leaf, describes complete line of gages, valves, industrial and heating equipment.—Jas. P. Marsh Corp., 2073 Southport Ave., Chicago.

HUMIDITY INSTRUMENTS—Bulletin No. 108, includes direct-reading precision hygrometers, recorders, and other instruments.—Amthor Testing Instrument Co., Inc., Brooklyn, N. Y.

INSTRUMENTS—Bulletin MS-1, describes line of d.c. and a.c. switchboard instruments and panels.—Columbia Electric Mfg. Co., 1292 E. 53d St., Cleveland.

LATHES—Booklet No. 101-A, 12 pages, "Underneath Belt Motor Driven Lathes," for maintenance shops.—Technical Service Department, South Bend Lathe Works, South Bend, Ind.

LIGHTNING ARRESTERS—Booklet, "Unseen Features of Crystal Valve Arresters."—Electric Service Supplies Co., 17 and Cambria Sts., Philadelphia.

LUBRICATION—Booklet, 50 pages, "Lubrication of Bearings."—The Pure Oil Co., Chicago.

MAGNETIC EQUIPMENT—Bulletin No. 100, "The House of Magnetic Magic," what the Stearns Testing Laboratory offers on magnetic separation problems.—Magnetic Manufacturing Co., Department TL, Milwaukee, Wis.

MASK—Bulletin, "At Last, A Sand Blast Mask That Is 99% Efficient."—Chicago Eye Shield Co., 2300 Warren Boulevard, Chicago.

MOTORS—Bulletin, 6 pages, "Long-Hour-Duty Split-Phase Motors."—Wagner Electric Corp., 6412 Plymouth Ave., St. Louis.

PIPE CUTTER, THREADER—Folder, "The Beaver Model—A ½- to 2-in. Electric Pipe Machine." — The Borden Co., Warren, Ohio.

PUMPS—Bulletin 149, "Morris Side Suction Pumps."—Morris Machine Works, Baldwinsville, N. Y.

PUMPS—Bulletin D-111-S4A, "Hivol Piston Pumps for Handling Highly Volatile Liquids," and Bulletin D-111-S3A, "Horizontal Piston Pumps for General Service."—Worthington Pump and Machinery Corp., Harrison, N. J.

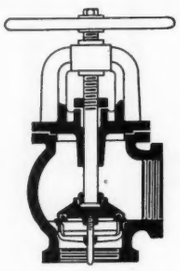
PUMPS—Bulletin No. 217, 36 pages, entire Nash line.—The Nash Engineering Co., South Norwalk, Conn.

(Continued on advertising page 42)

Data Sheet

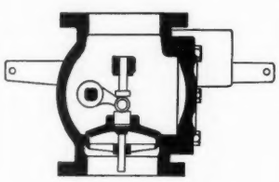
Valves—*Materials, Types, Sizes*

KEY
R = Rising Stem
N-R = Non-rising Stem
S = Screwed Type
F = Flanged Type
L = Lever Type
G = Globe



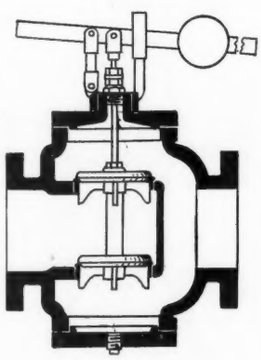
ANGLE

Bronze	R-S	¼- 3 in.
Bronze	R-F	¾- 3 in.
Cast Iron	R-S	2 -12 in.
Cast Iron	R-F	2 -14 in.
Cast Steel	R-S	¼- 4 in.
Cast Steel	R-F	¾-14 in.
Lead Lined	R-F	¾- 6 in.
Tin Lined	R-F	¾- 6 in.



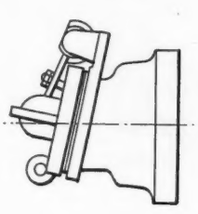
BACK PRESSURE

Cast Iron	F	1½-7 in.



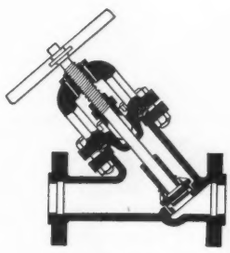
BALANCED

Bronze	S	½-2½ in.
Cast Steel	F	2 -10 in.



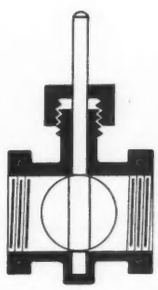
FLAP

Cast Iron	F	4-48 in.
Cast Iron	Bell	4-48 in.



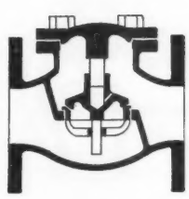
BLOW-OFF

Cast Steel	F	½-2½ in.



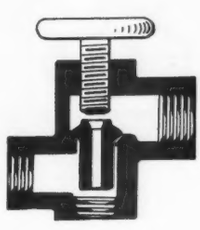
BUTTERFLY

Bronze	S	¾- 3 in.
Cast Iron	S	¾- 4 in.
Cast Iron	F	2 -16 in.



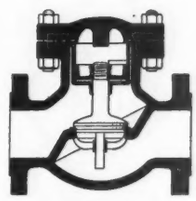
CHECK

Bronze	S	¼- 3 in.
Bronze	F	¾- 3 in.
Cast Iron	S	2 -12 in.
Cast Iron	F	2 -12 in.
Hydraulic	S	¾- 3 in.
Hydraulic	F	¾- 3 in.
Lead	F	¾- 6 in.
Cast Steel	S	¼- 3 in.
Cast Steel	F	2 - 6 in.



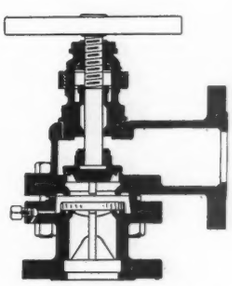
CHECK, BY-PASS

Cast Steel	S	½-¾ in.



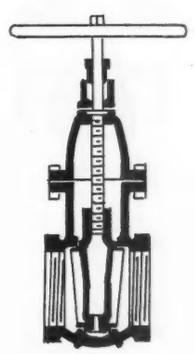
CHECK, CUSHIONED

Cast Iron	S	2½-10 in.



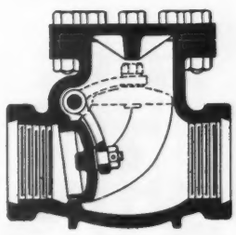
CHECK, STOP

Bronze	S	1½- 5 in.
Bronze	F	1½- 5 in.
Cast Iron	S	2½- 6 in.
Cast Iron	F	2½-10 in.
Cast Steel	F	2 -12 in.



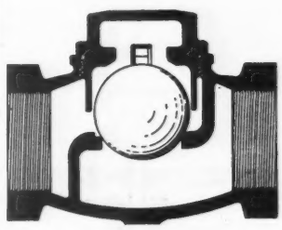
GATE

Bronze	NR-S	¼- 8 in.
Bronze	NR-F	¾- 8 in.
Cast Iron	NR-S	1½-10 in.
Cast Iron	NR-F	1½-16 in.
Cast Iron	R-S	1½-10 in.
Cast Iron	R-F	1½-48 in.
Cast Steel	NR-S	1½-14 in.
Cast Steel	NR-F	1½-16 in.
Lead Lined	R-F	¾- 6 in.
Rubber	R-F	2 -12 in.
Sil. Iron	R-S	½-12 in.
Cast Iron	L	2 -12 in.



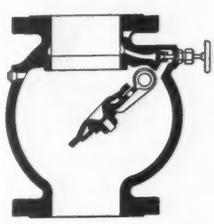
CHECK, SWING

Cast Iron	S	2-12 in.
Cast Iron	F	2-24 in.



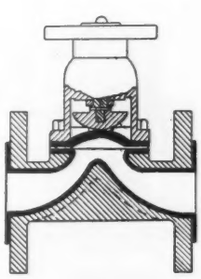
CHECK, BALL

Bronze	S	¼-3 in.



EMERGENCY STOP

Cast Iron	F	3-10 in.
Cast Steel	F	3-10 in.



DIAPHRAGM

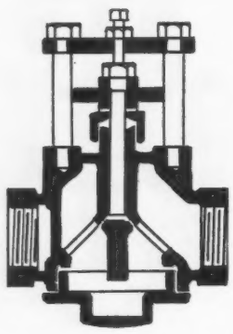
Lead	F	¼-2 in.
Rubber	F	1 -4 in.

(Continued on next page)

Data Sheet

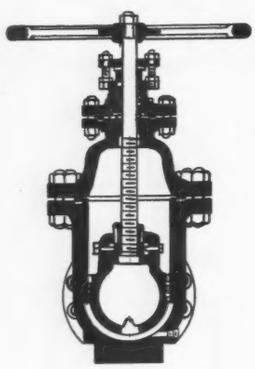
Valves—*Materials, Types, Sizes*

(Continued from preceding page)



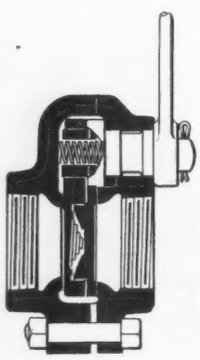
CHRONOMETER

Cast Iron	S	3- 6 in.
Cast Iron	F	4-12 in.



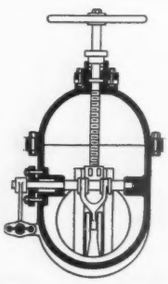
DRILLING

Steel	S	4-14 in.
Steel	F	4-14 in.



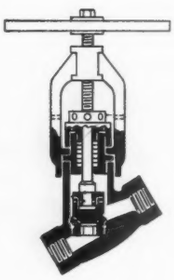
DISK

Brass	S	¼-4 in.
Brass	F	1 -4 in.
Cast Iron	S	¼-6 in.
Cast Iron	F	1 -6 in.



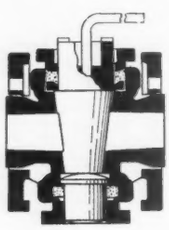
SWING, GATE

Cast Iron	R-S	2 -12 in.
Cast Iron	NR-S	1½-24 in.



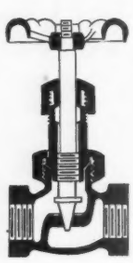
HYDRAULIC

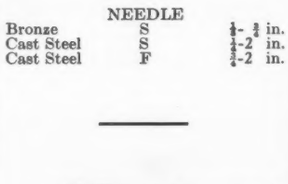
For. Steel	S	¾-4 in.



PLUG

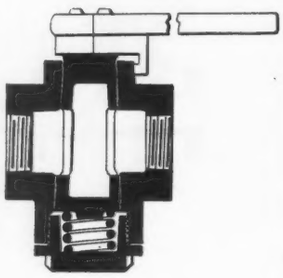
Sil. Iron	F	½-4 in.





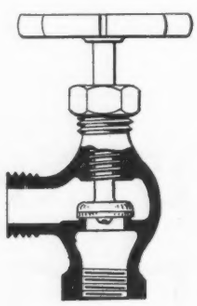
NEEDLE

Bronze	S	⅛- ¾ in.
Cast Steel	S	¼-2 in.
Cast Steel	F	¼-2 in.



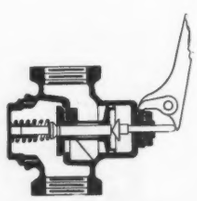
COCK

Lead	S	¼-3 in.
Lead	F	-3 in.
Ceramic	S	-4 in.
Ceramic	F	-4 in.
Ceramic	3-way S	-4 in.
Ceramic	3-way F	-4 in.
Ceramic	90-deg. S	-4 in.
Ceramic	Block	-4 in.
Bronze	S	-3 in.
Bronze	F	1 -3 in.
Cast Iron	S	-8 in.
Cast Iron	F	-8 in.



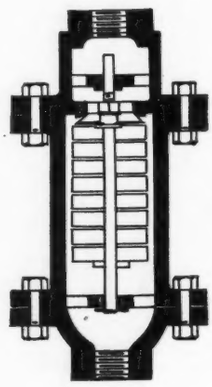
HOSE

Brass	S	¾-2½ in.
Bronze	S	½-2 in.



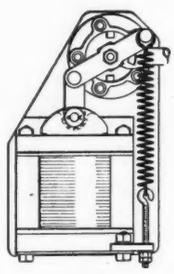
WHISTLE

Brass	S	¼-3 in.



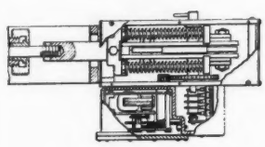
POPPET

Cast Iron	S	¾-3 in



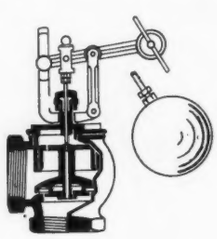
SOLENOID

Cast Iron	S	¼-1 in.



MOTOR-OPERATED

Cast Iron	F	1½-60 in

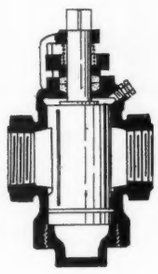


Data Sheet

Valves—*Materials, Types, Sizes*

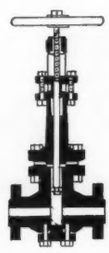
FLOAT

Bronze	S	½- 4 in.
Cast Iron	S	¾- 4 in.
Cast Iron	F	½-16 in.



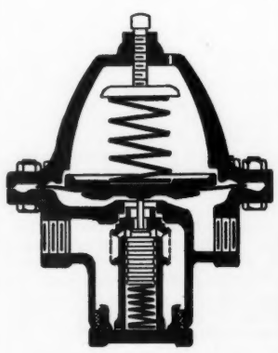
ROTOR

Cast Iron	S	½-4 in.
Cast Iron	F	1½-6 in.



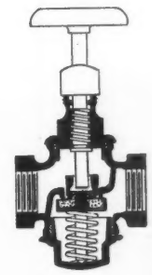
SLIDE

D. F. Steel	F	1¼-4 in.



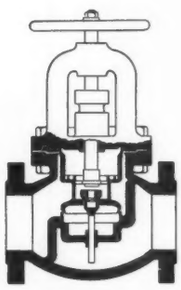
REDUCING

Cast Iron	S	¾- 6 in.
Cast Iron	F	1 -12 in.



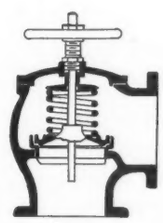
SELF-CLOSING

Bronze	S	½-2 in.



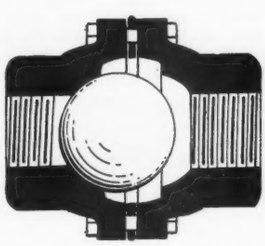
THROTTLE

Cast Iron	F	6-14 in.



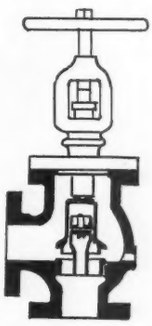
RELIEF

Cast Iron	S	½- 4 in.
Cast Iron	F	1 -48 in.
Cast Steel	L	¾- 3 in.
Brass	S	½- 4 in.



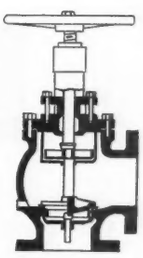
RETENTION

Cast Iron	S	¾-12 in.
Cast Iron	F	2 -12 in.



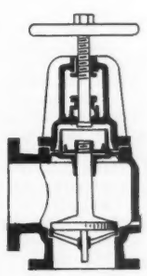
REVERSE-CURRENT

Cast Iron	F	2-10 in.
Cast Steel	F	2-10 in.



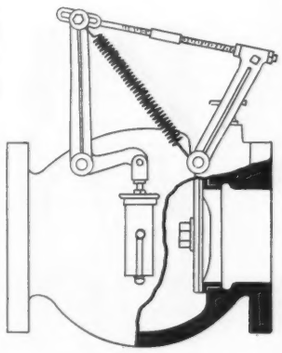
NON-RETURN

Cast Iron	F	4-10 in.



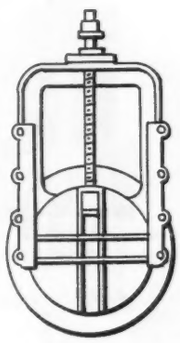
STOP, CHECK

Cast Iron	S	1 - 4 in.
Cast Iron	F	2½-10 in.
Cast Steel	F	2½-10 in.



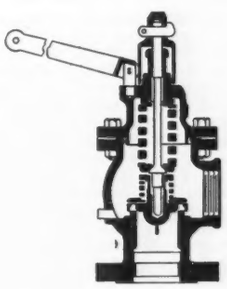
PRESSURE STOP

Cast Steel	S	¼-3 in.
Cast Steel	F	¾-2 in.



SLUICE

Cast Iron	NR-F	6-30 in.
Cast Iron	R-F	20-96 in.



SAFETY

Cast Steel	S	¾-2½ in.

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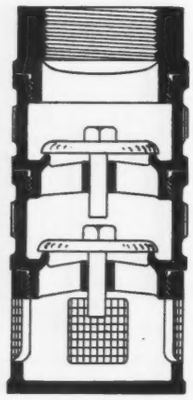
Data Sheet

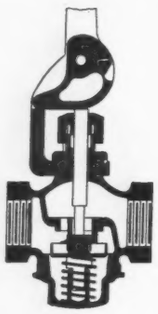
Valves—*Materials, Types, Sizes*

(Continued from preceding page)



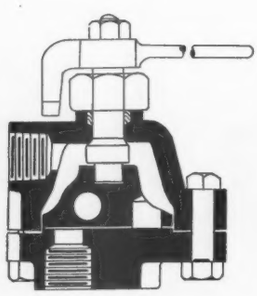
FOOT

Cast Iron	F	4 -48 in.
Lead	F	¼- 6 in.



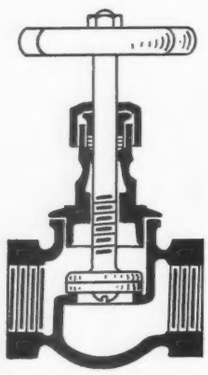
RAPID-ACTION

Bronze	G-S	¼- 2 in.
Cast Iron	L-S	2 -12 in.
Cast Iron	L-F	2 -16 in.



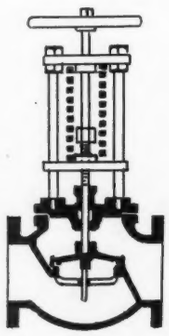
TWO-, THREE-, AND FOUR-WAY

Mal. Iron	S	¼-2 in.



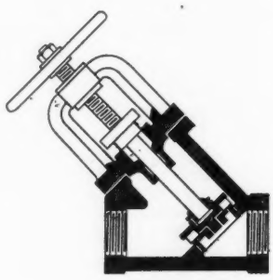
STOP

Bronze	S	¼-2 in.



RELIEF AND BACK-PRESSURE

Cast Iron	S	2- 6 in.
Cast Iron	F	2-24 in.



"Y"

Lead	F	¼-6 in.
Sil.	F	¼-4 in.

GENERALLY speaking, valves may be divided into two types: gate and globe. There are several minor exceptions such as chronometer, flap, diaphragm, and needle valves, but in the last analysis the exceptions are modifications of the two principal types.

Gate valves, in turn, are divided into two general classes, wedge and straight disks, and rising and non-rising, or outside screw and yoke, as this latter type is also called. The fundamental advantage of a gate valve is that it gives a straight line opening the full diameter of the pipe on which it is used. The disadvantages are that pressure is all on one side of the disk in opening and closing and the seats cannot readily be refaced.

Formerly it was general practice to use a gate valve on low pressures and a globe valve on high pressures, but improvement in design and workmanship have modified this practice to such an extent that gate valves are used on pressures up to 1,500 lb. per sq.in. and even higher.

The threads on the stem of the non-rising type are exposed to the fluid passing through the pipe and should be used on water, gas, and oil lines at normal temperatures. This rising, or outside-screw and yoke type, should be used on steam lines and under any condition where injury may occur to the exposed threads on the stem.

Of the exceptions to the two general types, the chronometer valve is used mostly on automatically controlled pipe lines such as steam-throttle and feed-water lines. The flap is used on check valves and on backwater valves of large diameter. Diaphragms are chiefly used in soft- and hard-rubber-lined valves to separate and protect the working parts of the valve from the corrosive fluids passing through.

Diaphragms are also used in regulating and reducing valves, but only as a sensitive device to open and close a valve or valves somewhere in the mechanism. Needle valves are used where only small regulated quantities of gas or fluid are wanted.

As with pipe and fittings, this compilation of valve types, sizes, and materials confines itself to the standard or generally used type of valve. It does not include highly special or complicated combinations of mechanisms and auxiliaries. In this connection, however, it may be well to mention recent developments in motor-operated valves. The use of motors in opening and closing valves is not new. The applications, however, have usually been to large sizes of valves and have been merely a motor mounted so that a pinion on its shaft would mesh with a gear wheel mounted in place of the regular hand wheel keyed to the stem of the valve. With this type the valve was opened and closed very rapidly and precautions were necessary in order not to overrun the stem in either direction. The size of motor necessary to open and close an unbalanced valve with a single gear reduction is expensive and usually out of proportion to the work done.

A recent development in motor-operated valves, brought about largely by air-conditioning installations, consists of a very small, comparatively cheap motor with as many as ten gear reductions. The valves used are either wholly- or semi-balanced and the stem is reciprocated by a cam at the end of the gear train. A series of switch contacts on an extension of the camshaft makes it possible to regulate the opening and closing of the valve with accuracy and uniformity. The closure mechanism is applicable to almost any valve and is comparatively cheap.

Radiator and car-heating valves are not included, because they are modifications of industrial valves.